POWER

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Learn To Arbitrate

DID you ever think how many lawyers and courts there are in the country and who supports them?

Do not think, because you do not have a lawsuit once in so often, that you are not interested.

Every court action that involves any individual, company or corporation whose products or service you use makes those products or services cost more to you unless their selling price is fixed with utter disregard of their cost.

And you pay the costs of both sides, the winner as well as the loser, and the upkeep of the court besides.

The crowded calendars and law's delay make it more costly and vexatious still.

And the "jury of his peers," called together to pass upon the facts involved and to render a verdict in accordance therewith, is often as incapable of arriving at an intelligent understanding of the case, especially if it involves engineering or other special considerations, as a group of stevedores would be to settle an argument on the Einstein theory.

A method has been provided whereby much of this litigation can be avoided and disagreements can be settled in the shortest time and at the least expense.

And it has been proposed and put into execution by the judges and lawyers in the same broad spirit in which preventive measures and research that will eradicate the diseases upon the treatment of which they thrive, are encouraged and supported and participated in by the big members of the medical profession.

The Arbitration Society of America is a non-profitmaking organization, the personnel of the board of governors of which is a guarantee of its public-spirited and unselfish purpose.

It encourages the writing of arbitration clauses into contracts, offers means of executing them before impartial and specially qualified arbitrators and seeks legislation making such clauses enforceable and incapable of rejection by an evident loser and giving to conclusions regularly arrived at, the force and authority of legal decisions.

In one year of its application, in a single industry, more than 5,000 cases were settled, the decisions being unanimous in over 90 per cent of the number. The money savings can be conservatively estimated at over a million and a half of dollars.

Two states, New York and New Jersey, have adopted satisfactory laws and efforts are being made for their extension. There is also a bill in Congress to make valid and enforceable provisions or agreements for arbitration of disputes arising out of contracts, maritime transactions or commerce among the States or Territories or with foreign nations.

It is a movement in which engineers who have so much to do with contracts and acceptance under them may well take an active and kindly interest.

Riverside Station of the United Light & Power Co.

Initial 25,000-kva. single-unit installation of a 150,000-kw. ultimate plant. Maximum use to be made of steam bled at four different points from main turbine for feed-water heating and air preheating. Plant will have evaporator and combination convection and radiant superheaters.

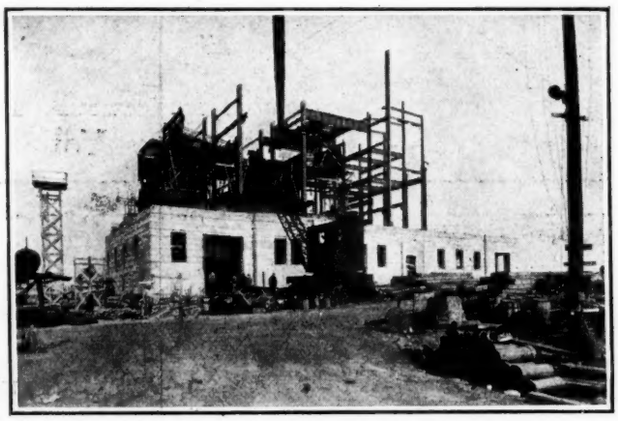

Fig. 1—Recent construction picture of plant

THE new Riverside Station of the United Light & Power Co. at Davenport, Iowa, is well under way. A single 25,000-kva. turbo-generator unit, with its auxiliaries and complement of four boilers and a building to house this equipment, comprises the initial installation. It is the expectation that within a reasonable time the ultimate capacity will reach 150,000 kw.

The station, being on the Mississippi River about six miles from the center of Davenport, with the manufacturing district extending toward it and the manufacturing center of Moline directly across the river, is closer to the load center than any other available site. Another advantage determining the selection of the site on the Iowa side of the river was its location on the Clinton, Davenport & Muscatine Railway, a company property participating in a division of the freight rates. The rock on the property is close to grade level, eliminating the need of costly foundations, and is sufficiently low near the river so that the cost of intakes will not be excessive. In the vicinity of the plant the river is particularly free from ice jams during the winter, and for a considerable distance up and down stream the rock bottom is free of silt, so that the water supply is better than the average on this river.

The plant being of moderate size, it was not considered desirable to select steam and other conditions or equipment that might necessitate substantial changes. At the same time the equipment was carefully selected and the steam cycle co-ordinated to give the highest possible economy. The operating steam pressure will be 400 lb. gage at the turbine throttle with a temperature of practically 700 deg. F.

Inasmuch as but one unit will be operated for some time, it will be necessary to follow the load curve and vary boiler steaming rather than change the number of boilers in service. For this reason combination radiant

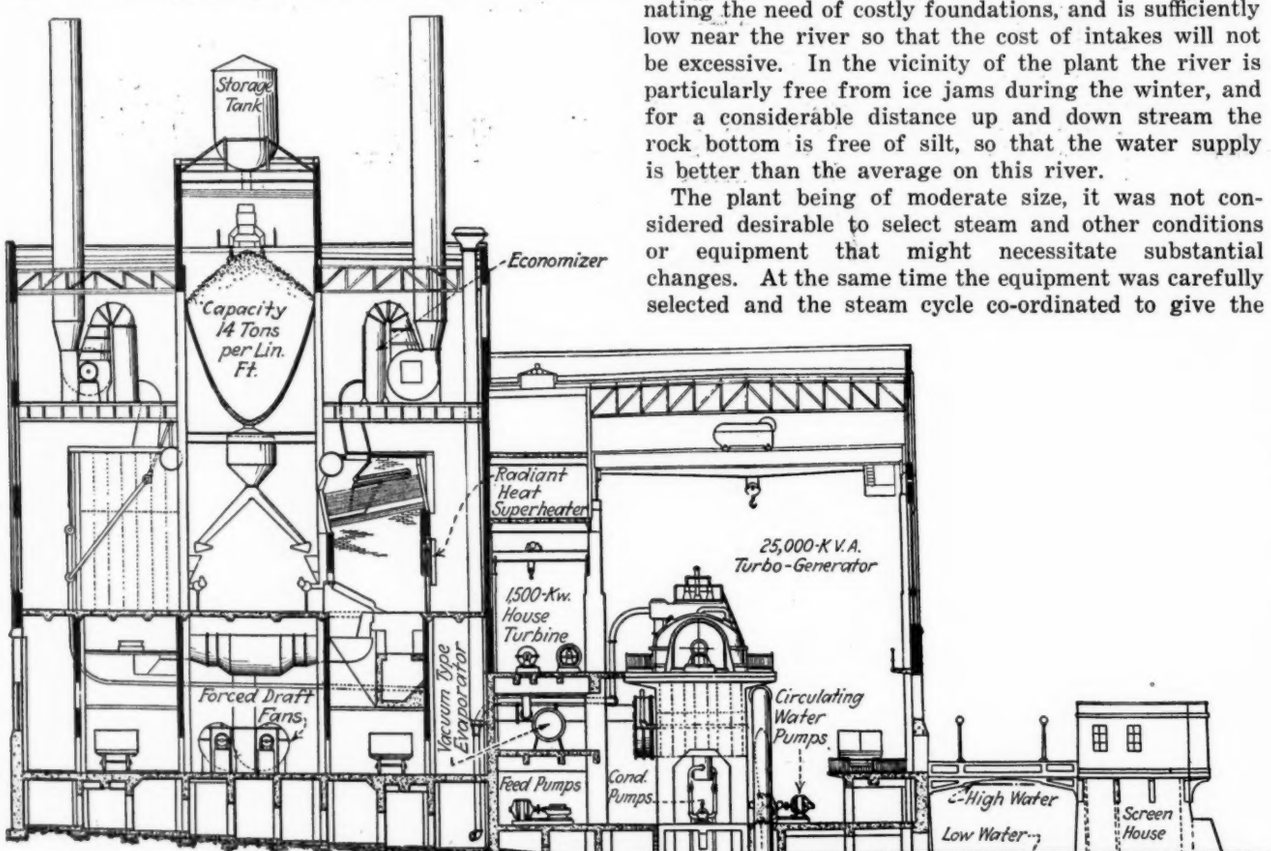

Fig. 2—Sectional elevation through Riverside station

and convection superheaters will be installed to maintain the steam-temperature curve as flat as possible. All the auxiliaries normally will be operated off the main bus, giving a maximum opportunity to bleed steam for feed-water heating, although for starting and emergency power supply for the auxiliaries, a house service turbine will be connected to the main bus through reverse current relays, the generator operating as a synchronous condenser with the turbine running at full speed without requiring steam for cooling.

To insure a 7 to 8 per cent increase in economy over straight condensing operation, the general plan will be

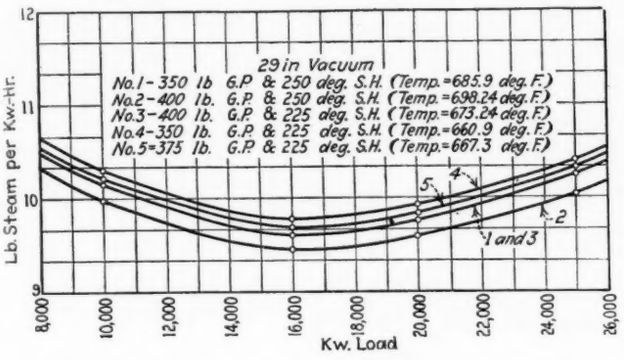
29 in Vacuum
No.1 - 350 lb G.P. & 250 deg. S.H. (Temp.=685.9 deg. F.)
No.2 - 400 lb. G.P. & 250 deg. S.H. (Temp.=698.24 deg. F.)
No.3 - 400 lb. G.P. & 225 deg. S.H. (Temp.=673.24 deg. F.)
No.4 - 350 lb. G.P. & 225 deg. S.H. (Temp.=660.9 deg. F.)
No.5 - 375 lb. G.P. & 225 deg. S.H. (Temp.=667.3 deg. F.)
Lb. Steam per Kw-Hr.
Kw. Load
1 and 3
2
4
5

Fig. 3—Economy curves of 25,000 kva. turbine

to bleed as much steam as can be used to advantage and pass as little steam as possible to the condenser. Stage heaters will extract steam from the main unit at four different points and, in conjunction with a high-pressure economizer and an evaporator to purify the makeup, supply water to the boilers at a temperature approximating 350 deg. F. An unusual feature is the placing of one of these stage heaters beyond the economizer, this being warranted from an economic point of view by an increase of 50 deg. in feed-water temperature.

Plans have been made for air heaters, although only one preheater will be installed now and the others later if the initial unit substantiates their usefulness. Instead of using an air heater beyond the economizer to absorb heat from the stack gases, it is proposed to eliminate the complications involved, such as the extra drop in pressure and the difficulty of keeping the surface cleaned for proper heat transfer through the tubes, by heating the air after it leaves the forced-draft fan and after entering the branch duct to the stoker, with steam bled from the main turbine. This will utilize some of the excess capacity for bleeder steam, and the higher air temperatures obtainable should improve combustion conditions.

An interesting feature in the design of the plant was a study of the comparative efficiencies of variable-speed alternating-current motors, direct-current motors and the use of two separate alternating-current motors of different speeds and capacities for driving the induced- and forced-draft fans, resulting in the selection of the two-motor drive with a saving in initial cost approximating $10,000. Other features of interest are the high-pressure steam piping, specially ventilated boiler settings, the support of the stub steel stacks, one per boiler, on the frames of the induced-draft fans, and the coal-handling system.

Fig. 2, a sectional elevation, shows the general arrangement of the new plant with the turbine room nearest the river to be adjacent to the water supply. The turbine and condenser are mounted on a reinforced-concrete foundation with only an operating gallery around the unit in preference to a main operating floor.

To serve the initial turbine unit, four cross-drum boilers, each containing 10,438 sq.ft. of steam-making surface, have been arranged two on either side of a central firing aisle. Originally, 13,000-sq.ft. boilers had been contemplated, but the installation of economizers containing 62 per cent of the boiler-heating surface, permitted the use of smaller boilers. Although the first decision had been for an operating pressure of 375 lb. at the boiler and 350 lb. gage at the turbine throttle, study of the economy curves of the turbo-generator showed that a saving of 0.15 lb. of steam per kilowatt-hour at the most economical load, 16,000 kw., could be effected by an increase in throttle pressure to 400 lb., which, with a superheat of 250 deg., gives a final steam temperature approximating 700 deg. F. At slight increase in cost the boilers have been built for these steam conditions, the curves of Fig. 3 showing the possibilities.

With the convection or radiant-heat type of superheater used separately, the degree of superheat tends to vary with the rate of boiler operation, the curve bending upward for the convection superheater and downward for the radiant superheater. By using these two types of superheater in series, a fairly flat curve

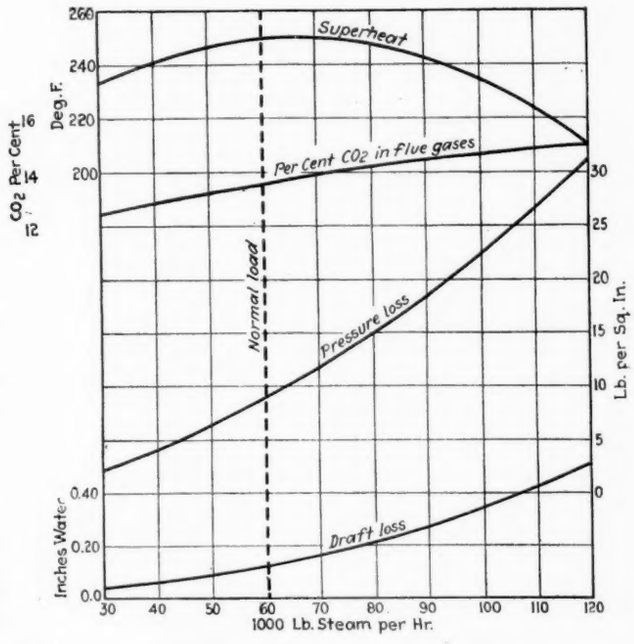

Fig. 4—Performance curves of combined convection and radiant superheaters

over the range at which the boilers will operate can be obtained. The convection superheater contains 2,925 sq.ft. of surface and the radiant superheater only 89 sq.ft., the ratio between the two being 33 to 1. The performance curve is shown in Fig. 3.

To give a long flame travel so that maximum results might be obtained from high-volatile coals, the stokers, which are of the underfeed type, are to be set under what is ordinarily termed the back end of the boiler. Both the stokers and the ash dumps are to be hydraulically operated, the great advantage offered by this type

of drive being positive regulation from maximum load down to a banked boiler. The bridge wall has been eliminated, and headroom of 16 ft. from the floor to the bottom of the front tube header provides the large furnace volume of 5,400 cu.ft. The radiant superheater will occupy the major portion of the rear wall. Opposite the inner end of the stoker will be a high-pressure water-back connected into the circulation of the boiler to prevent clinkering and adherence to the rear wall by taking the heat from the ash.

The boiler setting will have ventilated side walls and a front wall between the stoker hopper and the tube header through which air for combustion will be drawn from the top of the boiler room. An outer steel casing secured to the beams by capscrews, so that any section may be removed for inspection or repair of the furnace wall, will provide channels for the down-flow of air. Dampers at the tops of these ducts will permit regulation and adjustment of the air flow. This heated air will be drawn down into the fanroom, under the central firing aisle, by the suction of the forced-draft fans.

To make a flexible installation in which one fan may supply any boiler or at low ratings two boilers, the four fan units will discharge into a common duct. Through dampered outlets the air will pass into branch

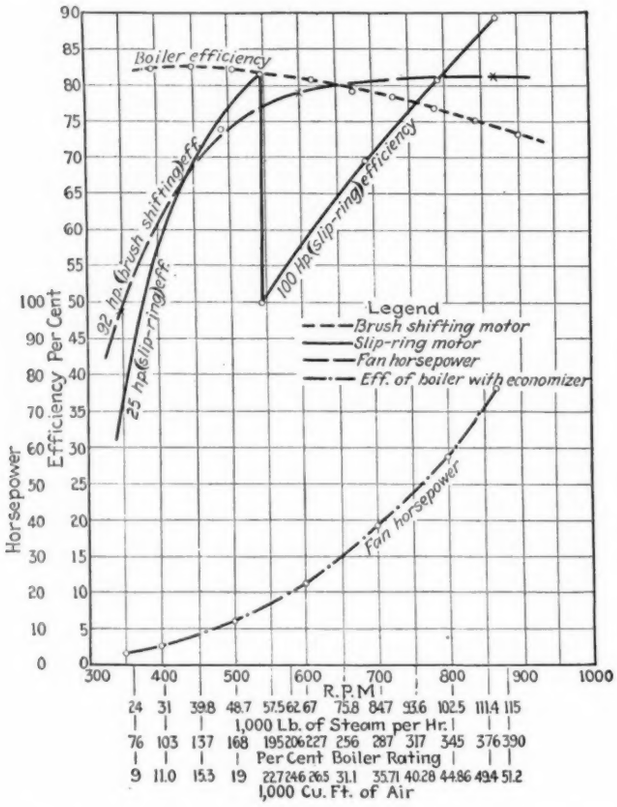

Fig. 5—Efficiency curves for forced-draft fan motors

ducts leading to the individual stokers, and it is in these ducts that the air preheaters are to be installed. Steam from the second-stage bleeder line at a pressure of 61 lb. abs. and 94 deg. superheat will be used in the heater, and it is expected that the air temperature will be raised 150 deg. F. on the basis of air entering at 100 deg. The amount of steam required by one heater should approximate 90 to 100 lb. per min. and the draft loss about 0.4 in. of water when the boiler is operating at the normal load of 200 per cent of rating.

Figs. 5 and 6 show the results of studies made to determine the relative efficiencies of single-motor versus two-motor drives for the forced- and induced-draft fans. For the forced-draft fans the comparison is between

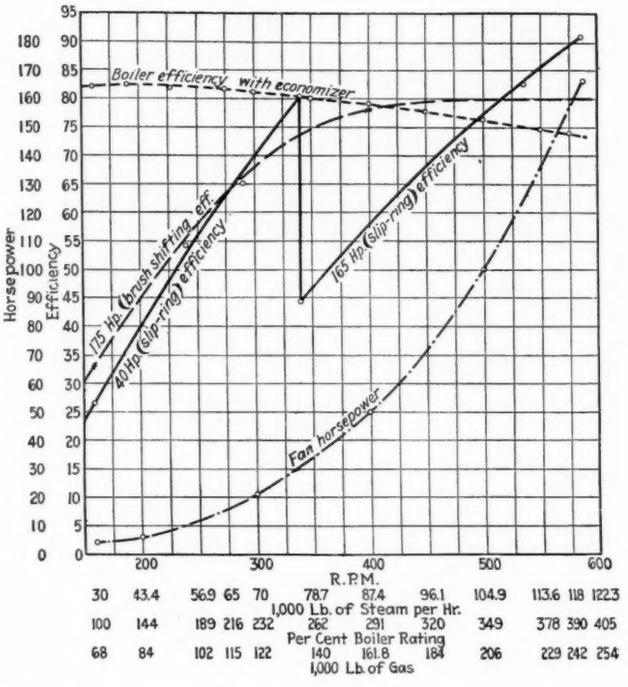

Fig. 6—Efficiency curves for induced-draft fan motors

a 92-hp. motor of the variable-speed alternating-current brush-shifting type and two slip-ring induction motors of 25 and 100 hp. capacity, respectively, one mounted at either end of the fan shaft. Fig. 5 shows that the 25-hp. motor is more efficient than the 92-hp. brush-shifting motor from 135 to 195 per cent of boiler rating. From the upper limit of this range the 100-hp. motor takes up the burden and its efficiency curve crosses that of the brush-shifting motor at 342 per cent of boiler rating. In other words, it is less efficient from 195 to 342 per cent of boiler rating, but capacity rather than economy is the principal factor in this range, which represents peak periods of operation, while normal operation falls within the range of the smaller motor. Another factor favoring the combination drive is the provision of two motors, either one of which will keep the plant in operation and thus doubly insure continuity of service. As previously mentioned, the combination of two standard motors is to be obtained at an initial cost some $10,000 lower than the price of the single brush-shifting motor.

Fig. 6 shows the study made for the induced-draft fan drive, with the result that the two-motor plan is to be adopted and the control is to be similar to that for the forced-draft fans. With an 84-in. double-inlet fan of 93,000 cu.ft. per min. capacity serving each boiler, larger motors will be required, the slip-ring motors being rated at 40 and 165 hp. respectively, and the brush-shifting motor at 175-hp., as indicated in the chart. A feature of the induced-draft fan installation will be the mounting of the stub steel stacks on the

reinforced casings of the fans with guys at the base to relieve side thrust on the casing. One steel stack 6½ ft. in diameter and 50 ft. high above the fan will serve each boiler. The stacks will be unlined.

Locations of the induced-draft fans and the high-

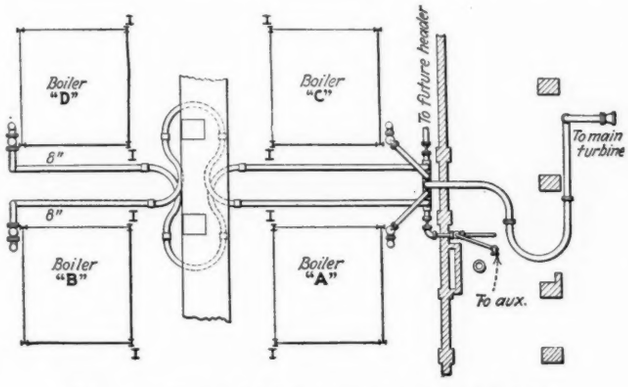

Fig. 7—Plan of high-pressure steam piping

pressure steel counter-current economizers are shown in the sectional elevation, Fig. 2.

An interesting feature of the boiler room will be the high-pressure steam piping. Owing to the stresses in the bends imposed by a steam temperature of 700 deg. F., it was decided to use seamless drawn tubing. The joints for the main part will be welded, although a ball-and-socket type of joint with Van Stone flanges is being considered. Another innovation is the possible use of Monel gaskets in the boiler-feed lines. Standard 500-lb. valves and 600-lb. flanges with male and female joints will be used. The high-pressure piping layout is shown in Fig. 7. From each of the four boilers 8-in. leads enter a central header which will have just sufficient length to accommodate the connections. The header, which will be 16 in. in diameter, will be made of steel tubing 1 in. thick and provided with welded nozzles. The 12-in. supply line to the turbine will be taken off the center of the header, and at the end of the header a connection will be made to supply high-pressure superheated steam for the auxiliaries.

In the leads from boilers *B* and *D*, the double return bends to care for expansion will be seen. From cold to hot the expansion in these lines will amount to 5¾ in. between the superheater and the header. To relieve the stress due to expansion, it is the intention to spring the piping into place cold, taking up 4 in. of the length. It is desired to limit the stress on the boiler leaders at the bends to 13,000 lb. per sq.in. Of this, the stress due to the steam pressure will amount to 3,815 lb. The supply line to the turbine also will be sprung into place cold, and even then a thrust of 1,000 lb. on the machine is anticipated.

While the possibilities of bleeding from the main turbine are not to be fully absorbed, still as much steam as possible is to be used for the various requirements about the plant. Fig. 8, an approximate heat diagram of the evaporator and heater system, shows the general arrangement and approximate quantities and temperatures at a 20,000-kw. load when using 6,075 lb. of makeup per hour with the raw fresh water at a temperature of 85 deg. The diagram shows the steam conditions at the four bleeding points and the connections to heaters, economizer and evaporator.

In the particular load conditions presented in the diagram, the boilers supply 220,925 lb. of steam per hour at 400 lb. gage pressure and 700 deg. F. to the turbine. At a point below the impulse blading the first bleeder line is taken off at a pressure of 149 lb. abs. and a superheat of 174 deg. F. This bleeder line supplies the first-stage heater through a desuperheater and the evaporator upon occasion, although the normal supply of steam for the evaporator is from the second-stage bleeder, taking steam from the turbine at 61.3 lb. abs. and 94 deg. superheat and passing it through a desuperheater between the turbine and the evaporator. The third-stage bleeder, taking steam at 14.7 lb. abs. at a quality of 98.8 per cent, supplies the third-stage heater, and the fourth bleeder line supplies the fourth-stage heater, the pressure in the latter case being 3.54 lb. abs. and the quality of the steam 94 per cent. The vacuum on this heater is maintained by a small line that leads to the main condenser.

It will be observed that each heater is drained to

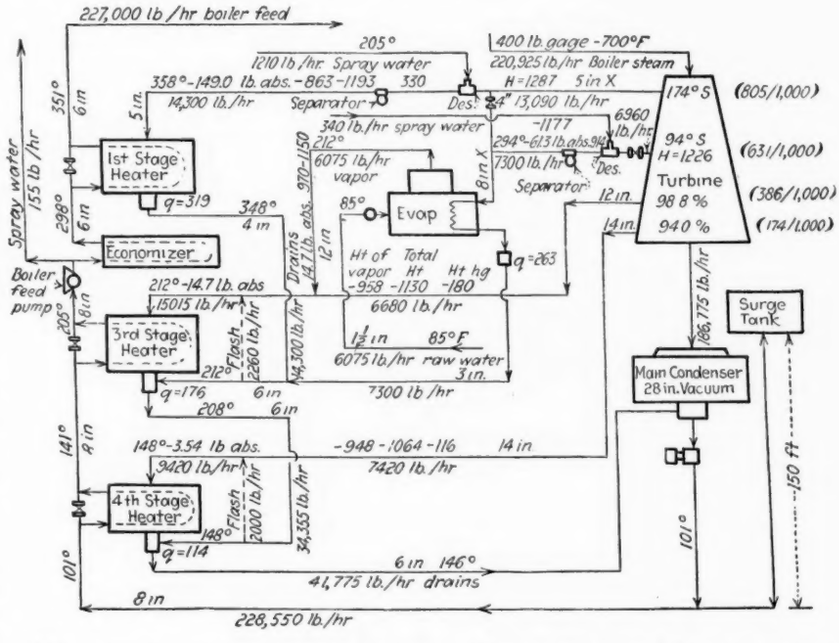

Fig. 8—Approximate heat diagram of evaporator and heater system with 20,000-kw. load

the hotwell of the succeeding heater and provision is made for the flash to enter the supply to this heater. The total condensate from the heater system thus passes to the hotwell of the fourth-stage heater and from here is drawn to the hotwell of the main condenser to flash it and remove any air that might be entrained during the cycle.

From the condenser hotwell the condensate pump passes the boiler feed through the generator air cooler, the inter- and after-condensers of the radojets and

through the fourth- and third-stage heaters to the suction of the boiler-feed pumps. If the supply of water is greater than the boiler-feed pumps will take, the condensate backs up into the surge tank shown at the right of the diagram and provided to take up any inequalities between the supply and the demand.

At the boiler-feed pumps the temperature has reached 205 deg. The economizer raises the temperature to 298 deg. F. and the first-stage heater adds 53 deg., so that the final temperature of the water upon entering the boiler is 351 deg. F. The drop in pressure from the condenser hotwell to the boiler-feed pumps, upon estimate, approximates 33 lb., and 28 lb. from the pumps to the boiler feed-water level regulators.

To simplify the connections between the boiler-feed pumps, economizers, first-stage heater and the boilers, and to increase the flexibility, the plant will be equipped with three 6-in. ring headers. Each of the three boiler-feed pumps discharges into the outer header from which the feed water passes into the economizers and returns to the second, or middle, header or, if desired, the water may be bypassed to the third, or inner, header. Normally, however, the water enters the second header and passes through the first-stage heater to the inner ring header, from which it

DATA ON PRINCIPAL EQUIPMENT IN RIVERSIDE STATION OF UNITED LIGHT & POWER COMPANY

GENERAL

Location of plant	Davenport, Iowa
Character of service	Light and power
Capacity, present building, kva	25,000
Ultimate capacity, kw	150,000
Boiler house, ft	96x90
Turbine room, ft	84x84
Width of firing aisle, ft	28

BOILERS AND SUPERHEATERS

Manufacturers	Heine Boiler Co.
Type of boiler	Water tube, cross drum
Number installed	4
Steam-making surface per boiler, sq.ft	10,438
Ratio steam-making surface to projected grate area	38.7 to 1
Furnace volume, cu.ft	5,400
Sq.ft. steam-making surface per cu.ft. of furnace volume	1.93
Cu.ft. of furnace volume per sq.ft. of projected grate area	20
Arrangement of tubes	15 tubes high and 33 wide
Size of tubes, in	3½
Boiler operating pressure, lb. gage	425
Superheat, deg. F	250
Steam temperature, deg. F	698
Type of superheater	Combination convection and radiant
Manufacturer	Power Specialty Co.
Surface in convection superheater, sq.ft	2,925
Surface in radiant superheater, sq.ft	89
Ratio convection to radiant surface	33 to 1

ECONOMIZERS

Manufacturer	Power Specialty Co.
Number	4
Type	Foster extended surface
Surface, sq.ft	6,480
Ratio economizer surface to steam-making surface, per cent	62
Method of cleaning	Diamond soot blowers and water flushing

FORCED- AND INDUCED-DRAFT FANS

Manufacturer	Green Fuel Economizer Co.
Forced-draft fans, double inlet, radial flow, 54 in	4
Capacity, static pressure 6 in., cu.ft. per min	67,000
Drive—Slip ring induction motors	25 and 100 hp.
Control	Push button, pilot motor and drum controller
Induced-draft fans, steel plate, double inlet, 84 in	4
Capacity static pressure 8 in., cu.ft. per min	93,000
Drive	Slip ring induction motors, 40 and 165 hp.
Control	Push button, pilot motor and drum controller

STACKS

Manufacturer	Cullen Co.
Number, one per boiler	4
Type	Stub, guyed steel unlined
Support	On reinforced induced-draft fan casing
Height above fan, ft	50
Diameter, ft	6.5

STOKERS

Manufacturer	American Engineering Co
Type	Taylor underfeed
Number per boiler	1
Size	10 retort, 33 tuyere
Projected grate area, sq.ft	270
Ratio steam-making surface to projected grate area	38.7 to 1
Drive	Hele-Shaw hydraulic

BOILER FEED PUMPS

Manfacturer	Allis Chalmers Mfg. Co.
Number	3
Type	Eight-stage, 525 lb. discharge
Capacity, gal. per min	Two 500 and one 300
Drive	300 hp. ind. motor, 255-hp. Kerr Turbine, 200 hp. slip ring ind. motor

HOUSE SERVICE PUMPS

Manufacturer	Allis Chalmers Mfg. Co.
Number	3
Type	Single stage, 20 and 100 lb. discharge pressure
Capacity, gal. per min	One 700 and two 300
Drive	15 and 40-hp. 1,800 r.p.m. ind. motors

HEATERS

Manufacturer	Griscom-Russell Co.
Number	3
Type	Closed
Capacity each, lb. per hour	240,000

EVAPORATOR

Manufacturer	Griscom-Russell Co.
Number	1
Type	High-pressure, single effect
Capacity, normal, lb. per hr	6,075

COAL HANDLING

Type	Belt conveyors
Furnished by	Brown Hoisting Machinery Co.
Capacity, 36 in., tons per hr	60 to 250
Crusher, Bradford breaker, tons per hour	250
Bunker, Ferroinclave, tons	924
Traveling weigh larry, tons	10
Yard storage, tons	60,000
Reclaiming, 15-ton locomotive crane, tons per hour	100

ASH HANDLING

Ash storage per boiler hopper, cu.ft	1,175
Gates, hydraulically operated	Baker Dunbar Co.
Number and size per hopper	Three 4x4 ft.

MAIN GENERATING UNIT

Manufacturer	Westinghouse Elec. & Mfg. Co.
Type	Single cylinder, parallel flow, reaction
Bleeding at	149.61, 14.7 and 4 lb. abs.
Capacity, kva	25,000
Speed, r.p.m.	1,800
Pressure at throttle, lb. gage	400
Superheat, deg. F	250
Type of generator	3-phase, 60-cycle, 13,200 volts
Ventilating air, cu.ft. per min	65,000
Air cooler	Griscom-Russell Co.
Exciter, direct connected, 250 v., kw	110
Exciter, motor-generator, 200 kw	Westinghouse Elec. & Mfg. Co.
House turbine, 1,500 kw., 480 v., 3 hp., 60 cycle	Westinghouse Elec. & Mfg. Co

CONDENSER

Make	C. H. Wheeler Mfg. Co
Type	Horizontal 2-pass
Tube surface, sq.ft	30,000
Tubes	1 in. No. 18 gage
Connection to turbine	Rigid
Support	Springs
Circulating pumps: Two 24-in. centrifugal pumps, combined capacity 32,000 g.p.m.; operating singly 21,000 g.p.m.; driver by 150-hp. slip-ring, induction motors, 20 per cent speed variation.	
Condensate pumps: Two 5-in. two-stage 600 g.p.m. pumps good for 180 ft. head, each driven by 50-hp. squirrel cage induction motor.	
Air pumps: Two Radojet pumps with inter and after condensers	
Screens, revolving, two 60-in	Link Belt Co.

MISCELLANEOUS EQUIPMENT

One air compressor, 12x7½x12, 327 cu.ft. per min. at 100 lb. pressure	Ingersoll-Rand Co.
One turbine-room crane, 100-ton, 4-motor	Whiting Corporation
One auxiliary crane, 35-ton	Whiting Corporation
Boiler and economizer soot blowers	Diamond Power Specialty Corp.
Steam separators	Griscom-Russell Co.
Oil filter	S. F. Bowser Co., Inc.
Water columns	Reliance Gauge Column Co.
Pressure differential regulators, Mercon	D. H. Skeen & Co.
Feed-water regulators, Copes	Northern Equipment Co.
Steam valves, high pressure	Lunkenheimer Co.
Steam valves, low pressure	Crane Co.
Stop and check valves	Schutte & Koerting Co.
Blowoff valves	Yarnall-Waring Co.
Safety valves, consolidated	Manning, Maxwell & Moore, Inc.
Atmospheric relief valves	G. M. Davis Regulator Co.

ELECTRICAL EQUIPMENT

Switchboard main	General Electric Co.
House service board	Westinghouse Elec. & Mfg. Co.
Oil circuit breakers, 73,000 v	Westinghouse Elec. & Mfg. Co.
Transformers	General Electric Co

passes through either one of two lines to feed in at both ends of the cross-drum of the boiler, giving in this way better distribution of the water in the drum and a more even temperature. The main feed line is equipped with a water-level regulator, while the auxiliary line is under hand control.

Raw water for house service and boiler makeup will be supplied to the plant through two 12-in. lines from the condenser intake. That portion of the service water entering the evaporator under float control is first passed through the oil coolers, transferring in this way the heat in the bearing oil to the boiler-feed water. Vapor from the evaporator and the drainage pass to the third-stage heater, which will operate at atmospheric pressure. An auxiliary supply of water will be stored in a 15,000-gal. tank that will be placed on the roof over the coal bunker. The water will be taken from a flowing artesian well on the property, and while normally it will be used for drinking purposes and bearing cooling, it will serve also as an emergency supply for fire protection.

Ordinarily, coal for the plant will come in by rail over the interurban line operated by the company, although provision will be made to unload from barges on the river by means of a locomotive crane with a 50-ft. boom operating on the track serving the turbine room. Near the point of take-off from the interurban line a track scale has been provided to weigh the incoming coal. Four main spurs facilitate the distribution of the coal into yard storage, for which there is capacity for 60,000 tons, part of which will be arranged for under-water storage.

Coal for immediate use will be unloaded into a track hopper and by belt conveyor be elevated to the top of the breaker house situated 160 ft. from the unloading track and 320 ft. from the boiler room. In this house a 250-ton Bradford breaker will be the initial equipment, from which delivery will be made to an inclined belt conveyor equipped with an automatic tripper to deliver the coal into the overhead bunker in the boiler house, which will have a capacity of 14 tons per lineal foot, or a total capacity approximating 924 tons. Deliveries from the bunker to stoker hoppers will be made by means of a 10-ton traveling weigh larry.

In the turbine room the main generating unit, rated at 25,000 kw. at 100 per cent power factor, will consist of a parallel-flow turbine operating under a throttle pressure of 400 lb. gage and 250 deg. of superheat, at a speed of 1,800 r.p.m. Under straight condensing operation with 1-in. back pressure without bleeding, the water rate at the most economical point, 16,000 kw., will approximate 9.5 lb. of steam per kilowatt-hour. The generator will be a three-phase 60-cycle machine, delivering current at 13,200 volts, with a direct-connected 110-kw. 250-volt exciter. The condenser will be of the two-pass surface type with 1.2 sq.ft. of surface per kilowatt of generator rating.

To provide for variation in the temperature of cooling water and to insure reserve capacity, the condenser will be equipped with two circulating pumps having a combined capacity of 32,000 gal. per min., or when operating singly a capacity of 21,000 gal. per min., which will maintain a 28-in. vacuum on the turbine with cooling water at 80 deg. or less. The drive for either pump will be a 150-hp. slip-ring induction motor, equipped for 20 per cent speed variation in eight steps. Duplicate radojet units with inter- and after-cooler will remove the air, and for the condensate duplicate units will be provided with a pump capacity of 600 gal. per min. against a head of 180 ft., and the drive a 50-hp. squirrel-cage induction motor.

Ordinarily, current for the auxiliaries will be taken from the main bus through 2,000-kva., transformers. The auxiliary bus will be divided into two sections and the auxiliaries themselves into duplicate groups, each group including motors for each class of service and taking current from its respective section of the bus. Thus, one section acts as a reserve for the other to guard against shutdown in case of accident.

A 1,500-kw. house turbo-generator will be installed. With the main unit up to speed and voltage, the house generator will function as a synchronous condenser and float on the line. With a vacuum maintained on the turbine casing by means of the main condenser, no steam will be required in the turbine for cooling.

The new plant will be operated in parallel with the Moline station of the company on the opposite side of the river. The two plants are to be interconnected by two 66,000-volt transmission lines carried on steel towers. Owing to its lower efficiency the Moline plant will carry the wattless energy of the system. This decision had considerable bearing on the selection of a 100 per cent power-factor generator for the new plant. Other feeders, of which there will be three at the beginning, will go out of the station at 13,200 volts.

The switchhouse, to be a three-story structure, will be on the boiler-room side of the building and separated from the plant proper. This building will house the 13,200-volt bus structure and the main control board, the former on the second floor and the control board on the third floor. Plans have been made for a standard double bus layout with standard oil circuit breakers and disconnecting switches mechanically gang operated by a lever so interlocked with the oil circuit breaker that the latter must be opened before the disconnecting switch can be operated.

Fig. 9, a perspective view showing the preliminary architectual study of the ultimate plant, brings out the main features of the property including the provisions for unloading from rail or water transportation, the space available for yard storage, the grades that make it possible to bring standard cars into the basement for ash removal and cars into the turbine room for delivery of equipment, the easy "get-away" for transmission lines, the screenhouses built out into the river and the Government wing dam, of which advantage was taken to separate the condenser intake and discharge.

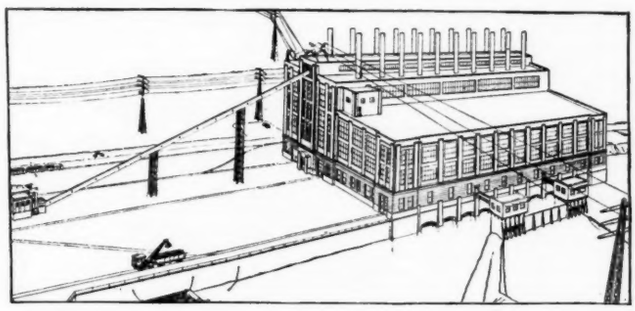

Fig. 9—Architectural perspective of ultimate plant

The design of the entire station, including the building, and the construction work, is being carried out by the United Light & Power Engineering & Construction Co.

The Economics of Interconnection of Large Steam Power Systems

By EGBERT DOUGLAS
Consulting Engineer, Milwaukee

IN THE popular mind superpower, or interconnected systems, are associated with cheap power, a fallacy that the technical press has consistently striven to controvert, pointing out that adequacy and continuity of service are the principal objectives. Even engineers sometimes follow a popular idea without regard to sound economics as applied to a particular case; hence the observations of Mr. Douglas deserve study and should provide the stimulus to profitable discussion.—EDITOR.

THE interconnection of large power systems by means of extensive transmission lines is a development of comparatively recent date. The economic benefits to be derived from these developments are still more or less uncertain.

In some sections of the country where water powers are found, the tieing together of such powers that are not too widely separated, appears to show fair possibilities of earning a reasonable return on the necessary transmission investment to effect these combinations. Engineering developments, however, often take the line of least resistance and follow the popular trend without due regard to whether the investments will stand on their own feet and pay their own way. Following the style, so to speak, of interconnections between large water-power systems, there is now going on a nation-wide agitation and in many sections actual development of interconnecting many systems where all the power or the major part of it is produced in steam plants.

The principal economic gain in tieing one or more large centers of power onto a steam power system is the saving in labor that might be effected in eliminating the one or more smaller plants thus replaced by the extensive transmission system. It is doubtful in some cases if the savings that the high-voltage lines and other paraphernalia are to accomplish will be sufficient to justify the transmission investment. For example, the coal cost in a good-sized steam power plant, say one of only 20,000 kw., will make up a very large part of the total cost of operating it. Operating labor and plant maintenance are relatively small items. The fuel cost frequently amounts to 70 per cent and sometimes 80 per cent of the total operating expenses.

With reasonable attention in design a 20,000-kw. plant can be made nearly as good, from a fuel consumption point of view, as a plant three or four times this size. No load centers requiring, say, only 10,000 kw. can be served from a long-distance transmission system without requiring some labor in its operation and maintenance. The combination of investment burden and operating labor in the super-transmission system, plus the production costs of power in the larger stations, may exceed the costs in relatively small steam plants at or near the point of power consumption.

The continuity of service will not be anything like so good with the long-distance transmission scheme, and the quality of service otherwise will be no better.

It is claimed that the diversity of loads in the different centers would greatly improve the load factor by tieing them together. However, there appears to be little improvement in load factors as the systems grow even when serving our most densely populated areas.

Observations of some of the largest systems indicate little or no improvement in load factor as the business expands. Outgrowth is large, but the peak load grows as fast or even faster, and while the volume of business done has increased, the loading on the stations remains in the same relative position. Consequently, the investment in plant, transmission and distributing systems has mounted higher and higher with the peak loads thus encountered. The more territory covered, the greater will be the investment per kilowatt-hour sold. The most densely populated districts are now served, and the territory that remains to be added is sparsely populated. The result is, the amount of energy sold per mile of additional line will gradually decrease. Station send-out and station peaks are apparently traveling in the wrong order so far as improving station loading is concerned. One company shows these figures:

Items	1917	1918	1919
Yearly output in thousands of kilowatt-hours.	1,488,080	1,508,070	1,628,340
Yearly peak in kilowatts	392,330	400,110	428,630
Equivalent hours use per year of peak load	3,800	3,760	3,740

The peak load increased about 36,000 kw. from 1917 to 1919, but the load factor remained substantially the same, about 45 per cent.

Another system looks like this:

Items	1917	1918	1919
Yearly output in kilowatt-hours	954,913,584	958,878,156	1,104,521,883
Yearly peak in kilowatts	278,097	286,103	330,210
Equivalent hours use per year of peak load	3,420	3,350	3,330

The output here increased about 16 per cent and the peak went up nearly 19 per cent in the same period.

A third system presents this picture:

Items	1917	1918	1919
Yearly output in kilowatt-hours	600,583,589	693,447,962	722,615,280
Yearly peak in kilowatts	148,931	166,294	199,247
Equivalent hours use per year of peak load	4,060	4,160	3,620

In this case the output increased 20 per cent from 1917 to 1919, and the peak on the station went up about 34 per cent. The additional sendout of 122,000,000 kw.-hr. came out of the station at about 27 per cent load factor.

Another system looks like this:

Items	1917	1918	1919
Yearly output in kilowatt-hours	265,430,474	293,966,604	328,798,850
Yearly peak in kilowatts	83,966	95,774	103,136
Equivalent hours use per year of peak load	3,160	3,080	3,180

The peak has gone up 20,000 kw. in the period from 1917 to 1919, with no marked improvement in load factor.

In a large manufacturing center we find this situation:

Items	1917	1918	1919
Yearly output in kilowatt-hours	672,200,600	773,876,700	872,583,200
Yearly peak in kilowatts	152,300	172,000	210,000
Equivalent hours use per year of peak load	4,400	4,500	4,150

The peak load increased 58,000 kw., or about 38 per cent, but in the same period the station sendout increased only 30 per cent.

In another manufacturing center we find this condition:

Items	1917	1918	1919
Yearly output in kilowatt-hours	444,735,309	543,663,042	576,131,649
Yearly peak load in kilowatts	113,228	128,319	153,878
Equivalent hours use per year of peak load	3,950	4,220	3,760

Here we find the station peak has gone up 40,000 kw., or about 35 per cent, and the sendout has increased only 30 per cent.

And in another center we see no improvement:

Items	1917	1918	1919
Yearly output in kilowatt-hours	343,523,580	433,196,550	392,201,280
Yearly peak load in kilowatts	69,980	82,760	80,640
Equivalent hours use per year of peak load	4,900	5,240	4,860

The added business here has not improved the station load factor, and the investment burden has steadily climbed.

The combined peak of the seven systems here referred to is in round figures 1,500,000 kw. The combined sendout in round figures is 5,600,000,000 kw.-hr. This is equivalent to 3,740 hours' use of the aggregate demand, or 42½ per cent load factor.

How much will the interconnection of big systems which are within reasonable distances improve the load factor? Will it be sufficient to pay a reasonable return on the costs of the necessary transmission to carry an appreciable amount of power?

There are no very definite figures yet published on what the results of the interconnection schemes yield, but apparently we cannot look for annual load factors of better than 50 per cent on the very largest of the interconnected systems.

Perhaps the largest amount of interconnected power is in the South, taking in both of the Carolinas, Georgia, Tennessee, Alabama and Mississippi. The capacity of the systems in this territory which are now operating interconnected is reported as follows:

Hydro-electric power	782,000 kw.	Per cent of total	70
Steam power	353,000 kw.	Per cent of total	30
Total power	1,135,000 kw.	Combined	100

Published figures indicate that these system encountered a peak of about 740,000 kw. and that their combined output was in round figures 3,250,000,000 kw.-hr. This is equivalent to an annual use of the peak of 4,390 hours, equivalent to about a 50 per cent load factor.

From the viewpoint of diversity this big system, extending into six states, with an aggregate load in round figures of one million horsepower, commercially uses the station peak scarcely more than 50 per cent of the time. This investment must represent a large amount of capital and the fixed charges against it work while we sleep as well as when the plants are loaded. The 50 per cent of the time the plants and transmission lines are doing nothing is a factor to be seriously reckoned with. A transmission system with no energy passing over it has not much earning power, nor does it have much to do with lowering production costs in the power plant.

The interchange of power in this particular locality may, and probably does, justify this vast interconnection network because there is considerable water power subject to wide fluctuations and the streams generally do not all rise or fall at the same time.

One-third of the total capacity, however, on this vast system is now in steam power plants, and the water storage capacity is equivalent apparently to less than 7 per cent of the annual output of the system.

The question now arises in sections where there is relatively little hydro-electric power, and where coal prices are not so far apart as water power and steam power costs, will these long and expensive transmission lines pay for themselves on the savings that can be honestly attributed to them?

Will these transmission systems in the steam power sections lower the prices of power, or will they eventually be the means of increasing them? The transmission systems have nothing to do with power production, and unless they carry a very large amount of energy, they may add considerable to the power cost.

The size of the system apparently has little beneficial effect on station loading, nor has it apparently any definite relation thereto. Therefore, the larger the system does not necessarily mean the lower will be power costs nor the better will be the station loading.

Increased Power Costs Possible

Eventually, this territorial expansion scheme may mean a decided increase in power costs, when some of the more or less uncertain elements are proved as to what measures may be required to maintain this transmission network permanently.

Much of the industrial power which these large systems now supply is highly competitive with power produced in small isolated plants. The rates have not always been made on a basis of the costs of production, transmission and transformation, but rather on a basis of what rate will get the business from the competitive isolated plant. Some of the industrial loads have been taken on at rates that yield a very meager profit, because higher rates would not get the business.

As coal continues to advance in price, and it surely will, power rates will necessarily have to increase. As they do so, the more attractive will the small steam power plants become, because the heating problems will become more important as coal goes up in price. Similarly, the uses for exhaust steam will become more pronounced as steam production costs increase, and a correspondingly larger amount of it will be used.

As the industrial executives get more intensively into their costs, which they will do as competition becomes more severe, the question of power and heating costs will be gone into in greater refinement in the small plants. Much power has been sold on meager information on the part of the user, and the economies in its use in some cases have been disappointing.

In many of our industries the costs of power are unknown, and all that is known about the coal burned is what it costs. What it produces or should produce has in the past been considered unimportant. The laymen are still mostly of the opinion that size of plant is the determining factor in fuel economy.

Power we must have, and the aggressive manufacturers will get their power the way they can get it the cheapest. Where fuel is the principal source of power supply, the recovery of the greatest amount of its heat will be the dominating factor.

Operation of Electric Elevator Machines —Traction Type Equipment

Construction of Drum-Type and Traction-Type Elevator Machines— The Operation of the Traction Type

By F. A. ANNETT*

ALTHOUGH the principle of the traction drive is old, its successful commercial application to an elevator has taken place within the last twenty years. With the drum-type machine, limitations as to the length and diameter of the winding drum restrict

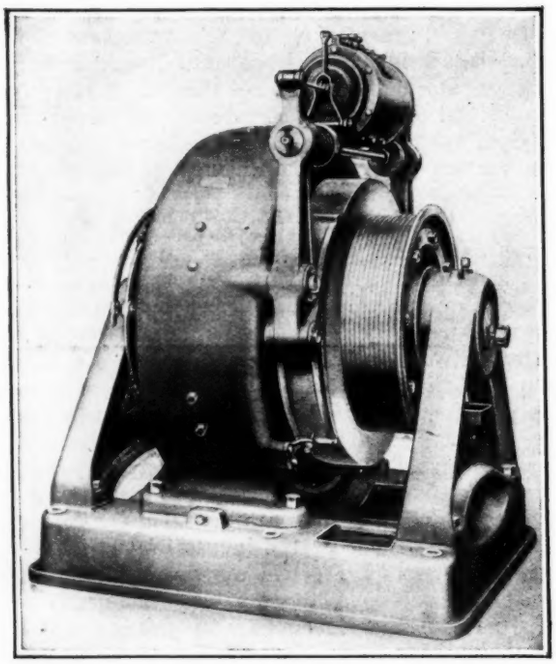

Fig. 1—Direct-traction elevator machine

the use of this machine to lifts of about 150 ft. or less. The advent of the modern skyscraper building made it imperative to develop a type of elevator that would be suitable to high-rises, and the traction-type came into commercial use. This machine has proved so successful that it is rapidly superseding all other types.

The highest development of traction elevators is found in the high-speed direct-traction, sometimes called gearless-traction, machine. A machine of this type, built by the A. B. See Electric Elevator Co., is shown in Fig. 1 and consists of a slow-speed (about 65-r.p.m.) direct-current motor having the traction sheave and brake wheel mounted directly on the motor shaft. To permit the use of a high-speed motor, geared-traction machines are used. One type of such an equipment as built by the Kaestner & Hecht Co., is shown in Fig. 2. This machine consists of a high-speed motor and a tandem worm and gear, one of the gear shafts being extended on which is mounted the traction sheave.

In addition to the foregoing arrangements a single worm and gear may be used; single worm and gear with internal spur gearing; single worm and gear with external spur gearing; single herringbone gearing; and car leveling single worm and gearing used in conjunction with either a direct-traction or a geared-traction machine on a micro-drive installation. Any of the machines may be roped single wrap or double wrap and for a 1-to-1 or a 2-to-1 speed ratio, as will be explained.

In the traction type of elevator machine, instead of winding on a drum as for the drum-type installation, the cables run over a traction sheave and unwind off as fast as they wind on. On the drum-type machine the grooving on the drum forms a helix like the thread on a screw and generally starts at one end and runs to the other. The grooves on a traction sheave form closed circles about the sheave, the number of grooves depending on the number of cables.

In Fig. 3 is shown a complete installation of a full-wrap direct-traction machine, roped for a speed ratio of 1 to 1, as built by the Otis Elevator Co. From this figure it will be seen that the cables pass from the car crosshead at *C*, over the traction sheave *S*, around the secondary sheave *S'*, then over the traction sheave *S* and to the counterweight crosshead at *W*. There are usually

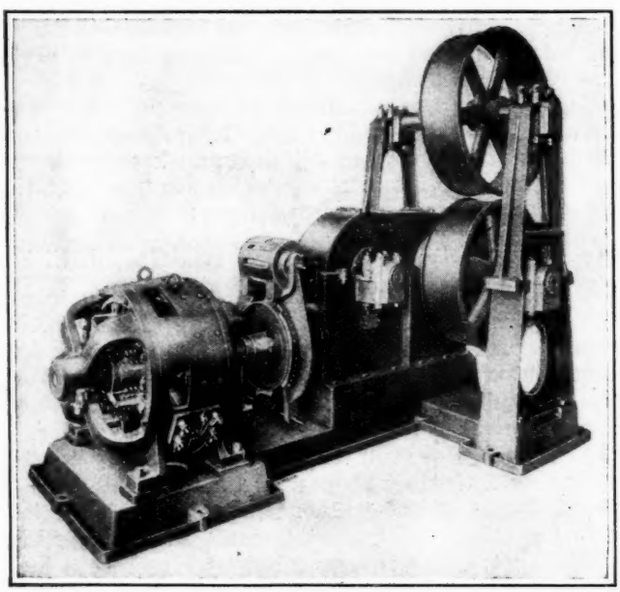

Fig. 2—Tandem-geared traction-elevator machine

6 cables used on these machines, and as the cables pass over the traction sheave twice, this sheave will have 12 grooves. On account of the cables making two half wraps around the traction sheave, this type of equipment is known as a full-wrap machine. A machine similar to that in Fig. 3 is shown in Fig. 7, from which

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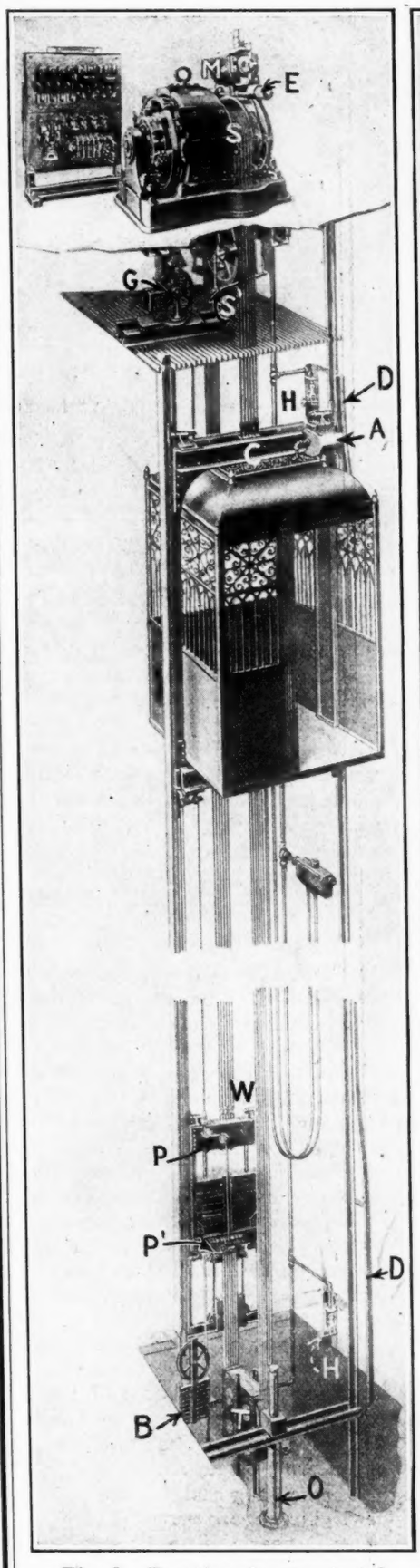


Fig. 3—Traction-elevator installation with 1-to-1 roping

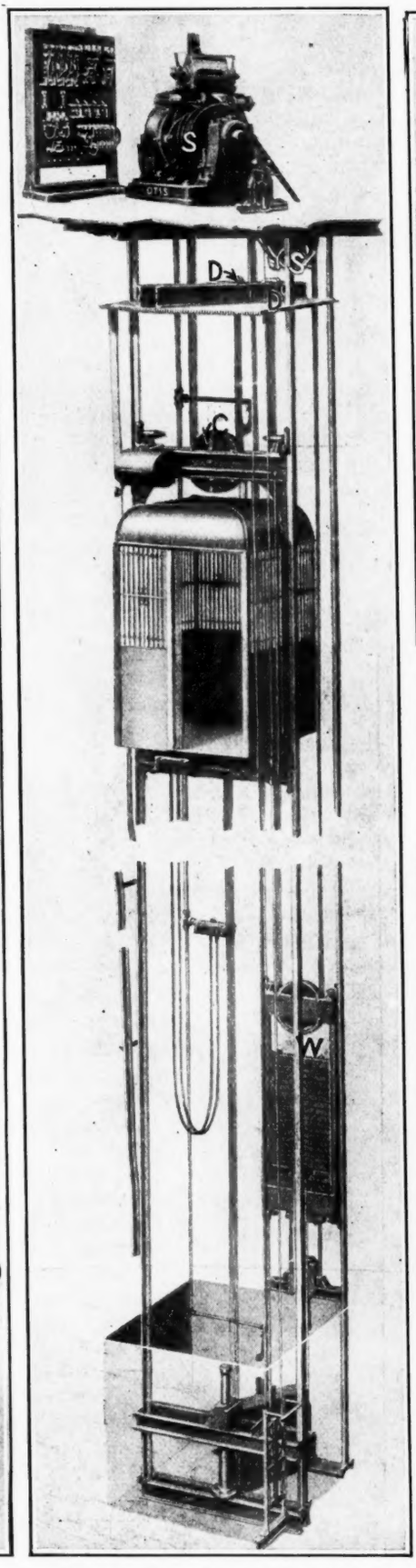


Fig. 4—Traction-elevator installation with 2-to-1 roping

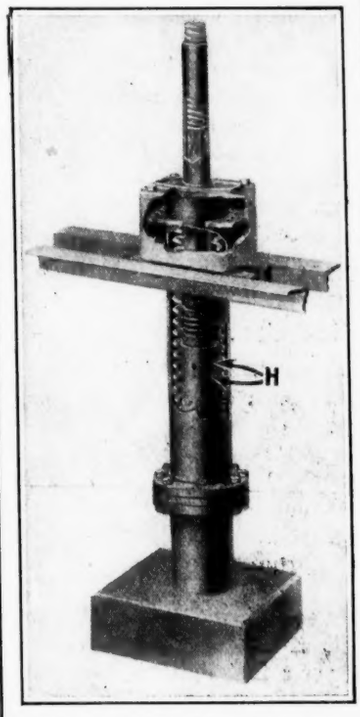


Fig. 5—Combination oil-spring buffer, which is placed at bottom of hatchway to bring car to rest in case of overtravel at bottom landing

Fig. 6—Car switch with cover removed for high-speed traction-elevator machine. The wheel is for operating the car safeties in case of emergency

the way that the cables pass around the sheaves may be more clearly seen.

The speed of the car depends on the size of the traction sheave and the speed of the motor. The traction sheave must be large enough in diameter so that the bending stresses in the cables will not be excessive and give a reasonable cable life. The minimum diameter of traction sheave is about 28 in., or about 40 cable diameters, where the maximum diameter is limited by the car speed required and it must not exceed the span between the car and counterweight centers. A sheave 36 in. in diameter and a car speed of 600 ft. per min. will require a motor speed of only $600 \div \frac{36 \times 3.1416}{12} =$ 63.6 r.p.m. From this it is seen that the speed of a motor on a direct-traction machine is necessarily very slow. On account of these limitations the direct-traction 1-to-1 machine is limited to a car speed of about 400 to 800 ft. per min. In Fig. 3 the car speed is the same as the cable speed, and for this reason the machine has what is called a 1-to-1 roping.

Machines with 2-to-1 Roping

In some installations a roping is used that will give a ratio of rope speed to car speed of 2 to 1 as in Fig. 4. In such installations the motor can be operated at double the speed for the same car speed obtained with a 1-to-1 roping. Or, conversely, the car speed with a 2-to-1 roping would be one-half that for a 1-to-1 machine using the same motor speed in both installations. The 2-to-1 type of installation is generally limited to where car speeds of 350 to 500 ft. per min. are required.

In the geared-type traction machine a high-speed motor is used and the desired car speed is obtained by using the proper gear reduction. Motor speeds for this type of installation vary from about 400 to 1,000 r.p.m., depending upon the size of the motor and type of installation. The geared traction is used with either a 1-to-1 or 2-to-1 roping and is applied to car speeds ranging from about 50 to 500 feet per minute.

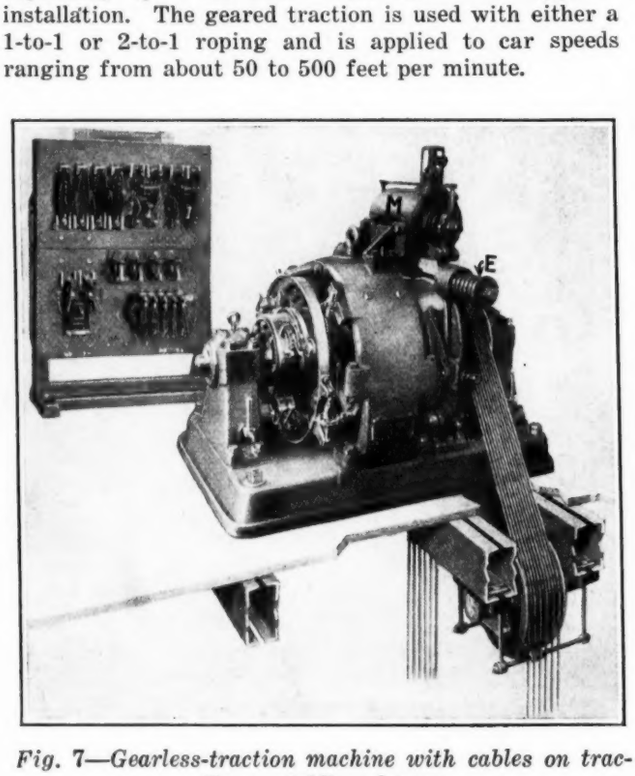


Fig. 7—Gearless-traction machine with cables on traction and idler sheaves

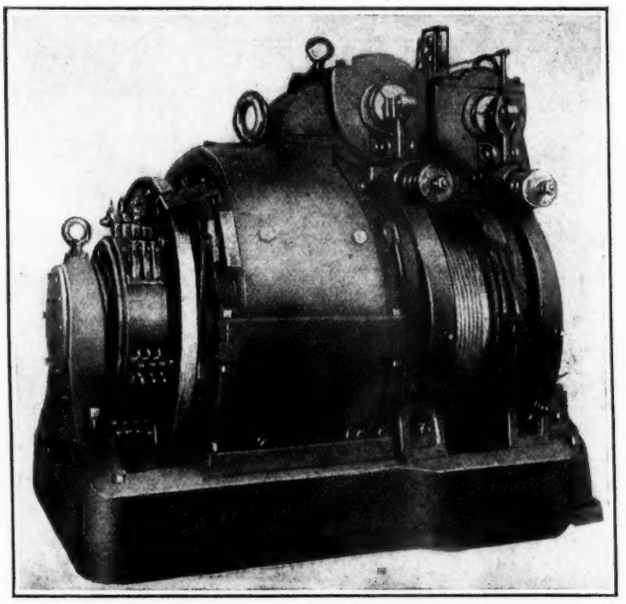


Fig. 8—Gearless-traction machine with two brakes

Certain installations require the application of a gearless-traction machine to a comparatively slow-speed installation, since the amount of power that can be transmitted by a worm and gear is limited to about 50 hp. There is no limit to the amount of power that can be applied to a gearless-traction machine, except the traction between the cables and traction sheave and the space requirements for the machine. At certain of the New York subway stations gearless-traction elevators that have a lifting capacity of 11,000 lb. at 350 ft. per min. are used. These machines have 2-to-1 roping and are the equivalent of a machine for a capacity of 5,500 lb. at 700 ft. per min. with 1-to-1 roping.

Safety Features of Traction Machine

One of the features of a traction elevator machine is that in case either the car or the counterweights bottom, the traction is lost between the cables and traction sheave and the car or the counterweights, as the case may be, will not be pulled into the overhead work as might happen with a drum-type machine. There is only one exception to this and that is in the case of a very high building, the weight of the cables hanging down the shaft may be great enough to maintain sufficient traction to lift the car or counterweights. To prevent this, some of the high-rise installations are equipped with retarding devices which come into action after a certain amount of overrun has taken place and prevent further travel of the car or counterweights, so that the cables must slip on the traction sheave.

In Fig. 3, in addition to the set of cables running from the top of the car over the traction sheave to the counterweights, a second set of cables run from the bottom of the car around a sheave *T* in the bottom of the pit up to the lower end of the counterweights. These are the compensating cables and compensate for the transferring of the hoisting cables' weight from the car to the counterweights or vice versa. For example, in the figure the car is near the top landing and the counterweights at the bottom. In this position most of the hoisting-cables' weight has been shifted to the counterweights; however, the weight of the compensating cables has been transferred to the car. Since the

two sets of cables weigh the same, there has been no change in the relation between the weight of car and counterweights. The sheave *T* and its housing on the compensating cables are free to move vertically on guides in the pit, and the weight of the sheave and housing is depended upon to keep a suitable tension in the compensating cables.

There are certain safety features provided by the compensating sheave in that if either the car or counterweights bottom, further motion lifts the sheave and tends to prevent the car or counterweight from being pulled into the overhead work as might be the case in very high rises. A switch is generally provided on the compensating sheaves so that in case it lifts above a certain point the switch opens and this in turn opens the main-line switch on the controller and cuts the power out of the machine entirely.

Oil Spring Buffers Used

Connected to the bottom of the counterweights is an oil spring buffer. A similar type buffer *O* is in the bottom of the pit to arrest the motion of the car should it go below the bottom landing. This buffer is so constructed that it brings the car loaded to rest from full speed without discomfort to the passengers. A sectional view of the buffer is shown in Fig. 5. As the buffer is compressed, oil is forced from the inner to the outer cylinder through holes indicated at *H*. When the piston is unloaded, the spring returns to its normal position.

On the high-speed traction machine safeties are used on both the car and counterweights. In Fig. 3 one side of the governor cable passes over two small sheaves at *P*, then down around the drum on the counterweight safeties and out over two other pulleys *P'*. From the counterweights the governor cable passes around the tension sheaves *B* in the pit and then to the car, where it is deflected over small idler sheaves under the car and makes two turns around the drum on the car safeties. From the car-safety drum the cable passes over an idler sheave to a releasing carrier at the top of the car and back over the governor sheave *G* to the counterweights. Should the hoisting cables part, the downard motion of the car and counterweights causes the governor cable to rotate the safety drums and apply the clamping jaws to the guide rails and bring both car and counterweights to rest.

In one type the safeties are held off the guide rails by an electromagnet under the car. In case of overspeed the governor opens a switch which interrupts the circuit to the electromagnet, which in turn allows the safeties to be applied by heavy springs and the car gradually brought to rest. In many installations a hand wheel is provided in the car, so that the operator can apply the safeties by hand in case the car should for any reason get out of control.

Operation of the Brake

The brake wheel and traction sheave are, on some direct-traction machines, keyed on the armature shaft, and in other cases bolted to the armature spiders. There being no reduction gear between the traction sheave and the brake, the latter must be strong enough to hold the maximum difference in weight between the car fully loaded and the counterweights. For this reason the brake is much larger than on a gear-type machine. The brake shoes are released by the magnet *M* and applied by heavy springs *E*, Figs. 3 and 7. Where direct-traction machines are to be used for safe lifting or other heavy purposes, they are sometimes equipped with two brakes, Fig. 8.

The control of the machine is from a switch in the car, as for a drum-type machine. However, where the machine is used for high speeds, it is possible to obtain as high as seven different speeds from the car switch. This is necessary not only for smooth acceleration, but also to allow the operator to make landing stops with ease. A car switch with the cover removed for a traction elevator machine is shown in Fig. 6. The hand wheel just below the switch is for applying the safeties in case the car gets out of control.

On account of cable creepage on the traction sheave, machine limits to stop the car at the terminal landings cannot be used as for the drum-type machine. Two general schemes of limit stops are used. With one arrangement a series of switches are located in the hatchway at the terminal landings and a cam is attached to the car, which opens these switches. The first switch to open slows the car down and the last brings it to rest.

In Fig. 3 the limit switches are mounted on top of the car at *A* and a cam *D* is mounted at both the top and bottom landings. As the car approaches the landing, the cam opens the limit switches and gradually brings the car to rest. Final limit switches *H* are mounted in the hatchway, so that if the car passes the landings it will open one of these switches, which in turn will interrupt the circuit to the potential switch on the controller and cut the power out of the machine.

Operation of a Machine with 2-to-1 Roping

With the exception of the method of roping up the machine to the car, the 2-to-1 direct-traction elevator is practically the same as the 1-to-1 machine. A complete 2-to-1 installation is shown in Fig. 4. One end of the hoisting cables is dead-ended to the overhead beams at *D*. From *D* the cables pass around a sheave *C* in the car-sling crosshead and back up over the traction sheave *S*. After passing around the traction sheave *S* and the idler sheave *S'* one-and-one-half times, the cables go to the counterweights and around under sheave *W*, then back to a dead end *D'* in the overhead beams. With this arrangement the car speed is only one-half that for 1-to-1 roping, with the same motor speed and same size traction sheave in both cases.

Instead of the idler sheave *S'*, Fig. 4, being directly under the traction sheave, as in Fig. 3, it is offset toward the counterweight side of the hatchway (also see Fig. 7). This is done where the distance from the center of the car to the center of the counterweights is greater than the diameter of the traction sheave. Where this condition exists, the idler sheave is used also as a deflector to lead the cables vertically down to the counterweights.

Another type of traction machine is that known as the V-grooved type, sometimes called pinch-groove or half-wrap machines. In such machines the grooves in the traction sheave are V-shaped and the cables pass directly from the car over this sheave to the counterweights. No idler sheave is used and the traction between the cables and sheave is obtained largely by the wedging effect of the cables in the grooves. This type of machine is rapidly coming into use. The cables make one half-wrap on the traction sheave, thus the name half-wrap type machine. Other types of traction machines have been developed and are in use, but those described give a good general idea of this class of equipment.

Causes of Flywheel Explosions Revealed

By EDW. INGHAM

CONTRARY to popular belief there is nothing mysterious about the breaking of a flywheel, for it is always traceable to the violation of an engineering principle.

Such explosions are generally caused through the wheels running at a greater speed than that at which they are intended to run. In consequence the stresses set up in the rim become so great that the wheel flies to pieces, often with the most disastrous results.

The manner in which a flywheel becomes stressed is not always clearly understood by many engineers. When the wheel is in motion, every particle of the mass tends to move in a straight line, a particle a in Fig. 1 unless constrained moving off at a tangent; but since actually it moves in a circle, it must be influenced by some force that acts toward the center of rotation. This force is known as a centripetal force. The equal and opposite force, acting away from the center, is termed the centrifugal force. The sum of the centrifugal forces acting on all of the separate particles which make up the rim, Fig. 2, constitutes the total force which tends to burst the rim into two equal halves across a diameter, just in the same way as the pressure in a steam boiler tends to burst the cylindrical shell into two equal parts and this force is resisted by the tensile strength of the metal. The stress on the metal can be found by dividing the square of the speed of the rim in feet per second by 10 or $f = \frac{v^2}{10}$. It is clear that the rim stresses due to centrifugal force depend entirely on the linear speed of the rim, if the resisting effect of the arms be neglected, and, contrary to the belief of some engineers, the sectional area of the rim does not enter into the question. In other words, no increase in strength can be obtained by increasing the sectional dimensions of the rim.

The formula also shows that the stress varies as the square of the rim speed. Thus, if the speed be doubled, the stress f is increased fourfold; if it be trebled, the stress becomes nine times as great as that caused by the normal speed of running. Consequently, a slight increase in speed will cause a considerable increase of stress, and any wheel will be burst if the speed be sufficiently augmented.

It must be understood that these remarks apply to a wheel which is in the form of a plain hoop. When the wheel has arms, as is always the case, each portion of the rim is subjected to more or less severe bending stresses, since the arms give a rigidity to the rim at the junctions of arms to rim, the effect being virtually that of beam fixed at both ends. These bending stresses are not important if the arms are close together, so that there is only a short length of rim between each pair of arms, but they may be serious when a small number of arms are used with a large-diameter wheel as in Fig. 3.

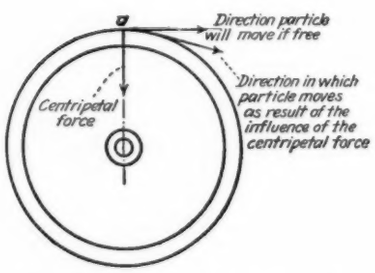

a
Direction particle will move if free
Direction in which particle moves as result of the influence of the centripetal force
Centripetal force

Fig. 1—Centripetal force makes the wheel go around

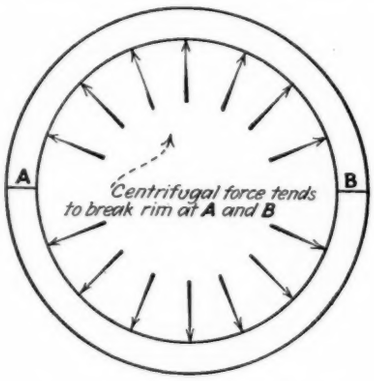


Fig. 2—Centrifugal force tries to pull wheel apart

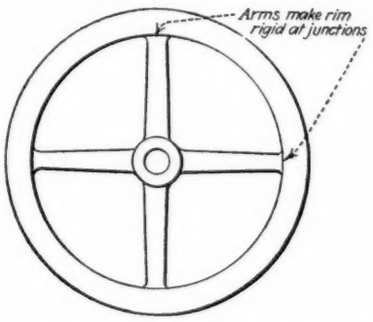


Fig. 3—Arms cause rim to act as fixed beams

In addition to the stresses set up in running, there may already be present initial stresses in the metal due to uneven cooling after casting of the wheel. These, of course, are indeterminate, but that they may be of great intensity is proved by the fact that wheels not infrequently fracture during the cooling after casting owing to the all-powerful atomic forces which are brought into play when different parts of the wheel cool down at unequal rates. Much may be done to minimize these latter stresses by careful design and casting.

With regard to the stresses due to centrifugal force, we have seen that these depend entirely on the rim speed and cannot be reduced by putting more metal into the rim. Obviously, to insure safe running, the rim speed must be kept within certain limits.

Assuming the ultimate stress of cast iron to be 14,000 lb. per sq.in., and allowing a factor of safety of 8, the safe stress is 1,750 lb. per sq.in. Hence, in the formula given we have:

$$1{,}750 = \frac{v^2}{10} \text{ and } v = \sqrt{17{,}500}, \text{ or } 132 \text{ ft. per sec.}$$

Thus the limiting speed is about 130 ft. per sec. for cast-iron wheels. In good practice it is not usual to allow the speed to exceed about 100 ft. per second.

The great majority of flywheels are made of cast iron, a material that not only has a low tensile strength, roughly about one-third that of wrought iron and one-quarter that of mild steel, but is likely to be stressed initially on cooling down after casting.

Wheels of wrought iron or mild steel, since these materials have higher tensile strength than has cast iron, are much superior to those of cast iron and can be run with safety at much higher speeds. Many wheels have been constructed partly of cast iron and partly of wrought iron or mild steel. One design of wheel, which appears to have been used with considerable success in a steel mill, has a rim of cast iron of channel section, this being wound round with many turns of

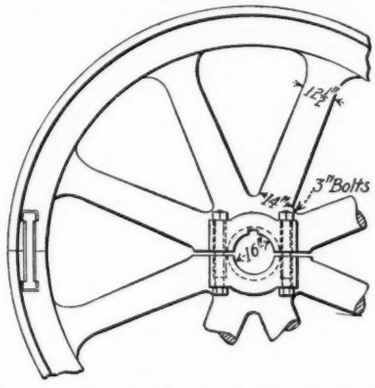


Fig. 4—A standard flywheel design

steel wire of high tensile strength. A wheel of this form can be run safely at three times the speed that would be safe for an ordinary cast-iron wheel.

Some years ago a wheel of unusual design was introduced by Professor Sharp. This wheel had a cast-iron rim connected to the boss by numerous spokes, the lengths of rim between the spokes being so small that the bending stresses are rendered unimportant. During construction, the spokes were exposed to an initial tension, so as to produce an initial circumferential compression in the rim. When the wheel was set in motion, the tension in the rim due to the centrifugal force was counteracted to some extent by the initial compression, so that the resulting stresses are comparatively small. The spokes were made from circular steel bars which were bent to a U form, the bent portion of each U being fitted into a spiral groove formed in the hub of the wheel, the ends being passed through a flange on the rim and firmly secured by nuts. By means of these nuts the tension in the spokes and the compression in the rim could be adjusted as desired.

The Function of the Governor

We have seen that explosions of flywheels are generally due to the wheels having attained a greater speed than that at which they are intended to run. The function of the governor is to maintain the speed of the engine more or less constant, no matter how the load on the engine or the boiler pressure may vary. Without a governor the engine would tend to gain speed, or "race," whenever the steam pressure increased or the load being driven diminished. The function of the flywheel is to maintain the speed of the engine more or less constant during each revolution, in spite of the fact that the turning effort is continually varying throughout each revolution. Without a flywheel the engine would tend to work with a jerky motion, the speed tending to accelerate during that part of each revolution when the turning moment acting at the crankpin exceeded the mean resistance and tending to decelerate on retard when the turning moment fell below the mean resistance.

Most cases of racing and bursting of flywheels are due to faulty operation of the governor or its mechanism. Failure of the governor to maintain the speed of the engine within the required limits may occur from other causes than breakage of the belt in the case of a belt-driven governor, or by breakage of the gear teeth of a gear-driven governor. Such trivial causes as the working loose of a setscrew or the binding of the governor spindle through defective lubrication have in the past been responsible for failure. In one instance where racing occurred and the flywheel burst, the trouble appears to have been caused through sticking of the spring in the steam-valve dashpot. Since so much depends on the governor, it is of the greatest importance that it should be maintained in reliable condition and frequently examined.

Electrical Stop Motions

Many engines are fitted with electrical stop motions, which not only shut off the steam automatically whenever the speed exceeds the normal, but enable the engine to be stopped by persons in parts of the works away from the engine room. Thus if an accident occurs in any room of the mill or factory, the pressing of an electric button is all that is required to bring the engine to a standstill.

It will be realized that when an engine begins to race, some little time must elapse before the speed of the flywheel reaches that at which bursting will occur. If the engine attendant is on the spot, he is able to close the stop valve immediately he realizes the engine is beginning to race, but if he is away from the engine room, the chances are that he will be powerless to avert an accident.

It will be observed that in such cases as this the gain of a few seconds may sometimes enable an accident to be prevented, and for this reason the suggestion has often been made that the valve should be placed near the engine-house door instead of near the high-pressure cylinder. The suggestion, however, seems rarely to be acted upon, and there are certainly objections of a minor character against the arrangement.

Cost of Oil-Engine Power Plants

Contrary to the prevailing belief Diesel-engine power plants do not cost much more than do modern steam plants. The Water and Light Department of Carthage, Mo., purchased a 750-hp. Diesel direct connected to a generator and later installed a 1,250 hp. unit. The costs were as follows:

750 HP. ENGINE	
Engine delivered at plant	$66,940.00
Generator	10,500.00
Oil tanks, foundations, pits, erection, changes to building, crane bridge and miscellaneous	15,500.00
	$92,940.00

1250 HP. ENGINE	
Engine and generator cost delivered	$104,625.22
Foundations	5,508.72
Cooler and muffler pits	757.89
Erection	2,665.63
Pumps, crane bridge, changes to building and all miscellaneous not including oil tanks	4,973.23
	$118,530.69

These data show that it is possible to install even a small Diesel power plant for less than $100 per kilowatt capacity.

Good Efficiency and High Rating with Unit-Type Pulverizers

By J. G. COUTANT

THE numerous power stations now using pulverized fuel, indicate the enormous progress that has been made. Statements of users confirm the merits that are attributed to the burning of coal in the pulverized form, although the methods employed differ greatly. Up

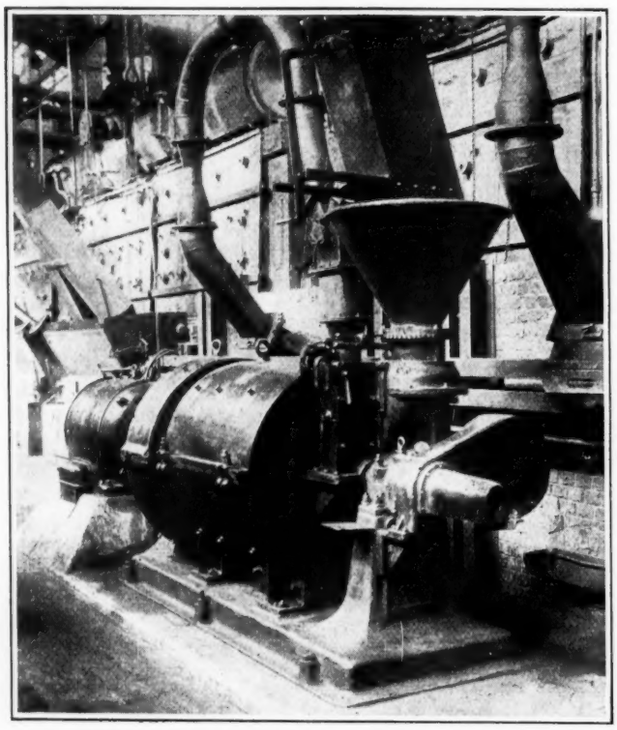


Fig. 1—One unit firing two boilers at Wasquehal Station

to the present year there has not been a universal trend in design for pulverized-coal installation, either for the machinery for preparation or for the combustion chambers in which the fuel is burned.

The curves Fig. 3 show graphically results obtained in several plants where large and small furnaces are used, which burn fuel at low and high rates of combustion per cubic foot of furnace volume per hour. Both types of furnace maintain the high economies and affirm the advantages and practicability of burning powdered coal.

These characteristics being generally accepted, the problem is now being studied from the financial angle. From the financiers' point of view a big reduction in first cost of installation and the elimination of some labor are demanded, with further economies to be established in maintenance and auxiliary power.

The large power stations at Wasquehal, Comines and Rouen, France, have apparently solved these questions by the use of the unit pulverizers which have been in service already for four, one and three years respectively.

The photograph Fig. 1 shows the interior of the Wasquehal Station, where fourteen boilers previously using stokers are now fired by seven unit pulverizers placed within a narrow firing aisle, and do not require any additional building space. The arrangement as shown has increased the boiler capacities and at the same time a greater variety of coals of high and low ash and moisture content are burned.

The power station at Comines, the newest among the large plants, has recently been extended, two additional 10,760-sq.ft. cross-drum boilers being installed, making a total of four boilers, each fired with two unit-type pulverizers.

The central station of Rouen has several 5,000 sq.ft. boilers, that are used during peak-load periods, being lighted each morning and evening for two hours' operation, showing the flexibility of the unit system that

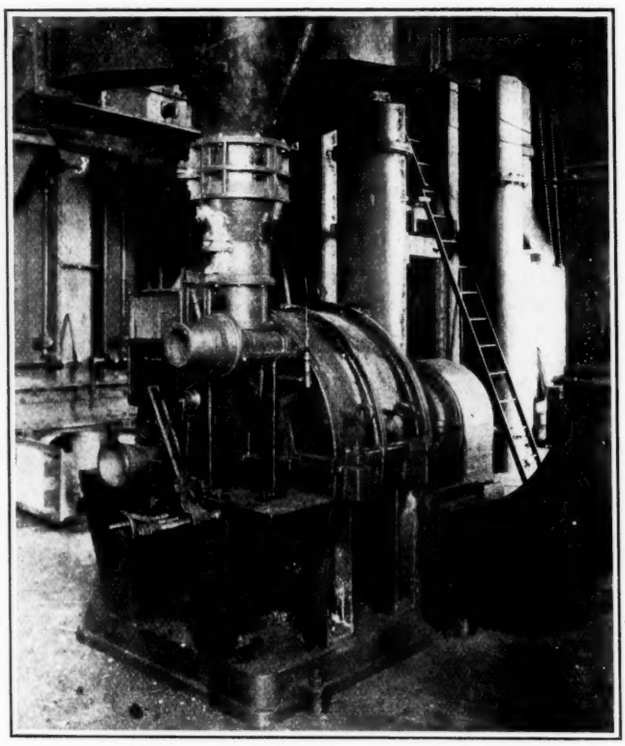


Fig. 2—Unit of 10,000 lb. per hour capacity at Sherman Creek station

carries with it minimum fixed charges and requires a small amount of attention.

The type of machine first installed at Wasquehal and Rouen Stations, shown in Fig. 1, is an interesting comparison with the unit-type pulverizer Fig. 2 recently developed in this country and installed at the Sherman Creek Station of the United Electric Light & Power Co., where several systems are being tried out.

It would appear that the trend in design of pulverized-fuel plants is toward the unit systems, as practically all manufactures of pulverized-fuel equipment are putting these machines on the market. This class of machine is practically noiseless and vibrationless, and eliminates risk of explosions and fires.

Large Furnace Volumes Required

The principal objection that has been made to the use of pulverized coal from the user's point of view has been the large furnace volumes that are usually recommended. These require special building construction, and are otherwise costly. The large furnace volumes have been required because of the methods of introducing the air in order to burn fuel at low rates of combustion, the low rate being considered necessary to lessen the brickwork maintenance and to avoid slag troubles.

The recent developments at the Sherman Creek Station are of considerable importance, the furnace being approximately one-half the volume of what is ordinarily recommended, in which coal is burned at a high rate of combustion per cubic foot of furnace volume per hour, as shown by the curves Fig 3. And there is every indication that the high boiler efficiencies shown will soon be attained. In considering the results obtained with Bettington boilers, this is a conservative statement and is within the neghborhood of the furnace and boiler performance at Puget Sound Electric Light & Power Co., which company reports satisfactory operation since it started to burn pulverized coal seven years ago at its Western Avenue Station.

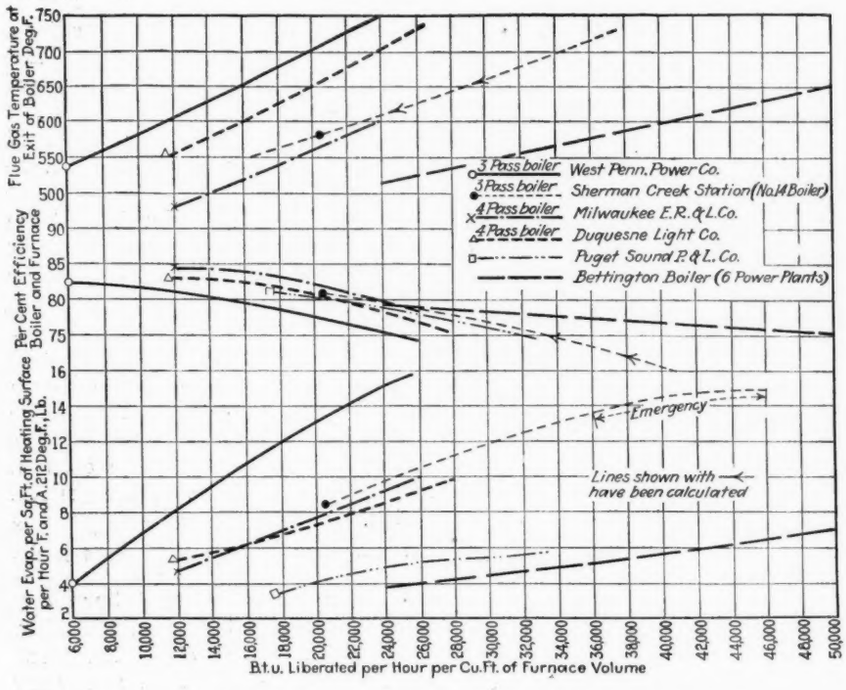
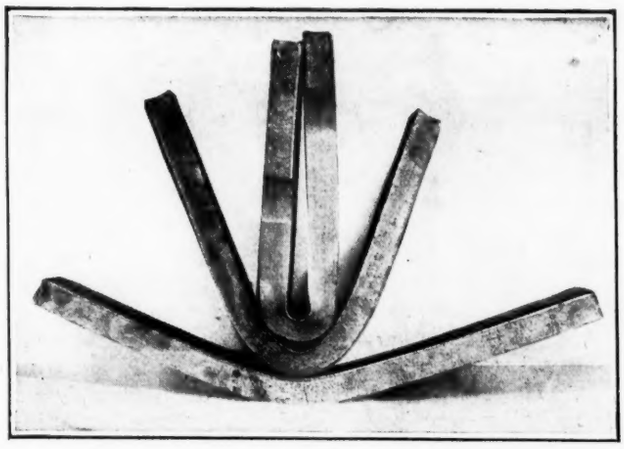

Flue Gas Temperature at Exit of Boiler Deg. F.
Per Cent Efficiency Boiler and Furnace
Water Evap. per Sq. Ft. of Heating Surface per Hour F. and A. 212 Deg. F., Lb.
3 Pass boiler West Penn. Power Co.
3 Pass boiler Sherman Creek Station (No. 4 Boiler)
4 Pass boiler Milwaukee E.R. & L. Co.
4 Pass boiler Duquesne Light Co.
Puget Sound P. & L. Co.
Bettington Boiler (6 Power Plants)
Emergency
Lines shown with have been calculated
B.t.u. Liberated per Hour per Cu. Ft. of Furnace Volume

Fig. 3—Results of several installations shown graphically

• One of the most common causes of the formation of blisters and sags in boiler tubes and boiler shells is the presence of scale. Every precaution should be taken to remove all pieces of scale after a boiler has been cleaned. By thoroughly flushing out with water, the floating impurities can be removed.

How Shearing Damages Thick Plates

Under the title, "Why A.S.M.E. Code Prohibits Punching and Shearing," an article in the December 16, 1924, issue of *Power* described recent experiments carried out by the Lukens Steel Co., to show the injurious effects of punching upon thick boiler plate. The experiments showed conclusively that the practice of punching holes full size in thick plates strained and embrittled the adjacent metal so that subsequent working or bending was much more likely to produce cracks and rupture.



Effect of shearing on one-inch thick steel

Top: Machined specimen. Center: Bent with fin on inside. Bottom: Bent with fin on outside.

The accompanying photograph shows the result of similar tests made with sheared plates. The specimen at the top was machined. It withstood bending, as shown, without cracks. The section in the middle was sheared and bent with the shearing fin inside, bending being stopped when cracks appeared. It will be noticed that this section withstood considerably less bending than the machined specimen. When a sheared section was bent with the fin on the outside, the appearance of cracks stopped the bending at the point shown by the lower specimen.

While the A.S.M.E. has always prescribed the planing of sheared edges to facilitate calking, the bad effects here shown would fully justify such a rule apart from any question of calking. The injurious effect of shearing is most noticeable in thick plates (those shown are one inch thick); but thinner plates are also affected.

Fuel-oil heaters should be opened up and cleaned out periodically. In the operation of the average plant this should be done at intervals of not less than three months. Deposits of carbonized oil and other impurities quickly lower the efficiency of the heater by preventing the passage of the heat from the steam through the heater walls to the oil.

Oil Engines For Refrigerating Plants*

By H. E. CHAMBERS, JR.

THE general statement may be made that, of all classes of industries, mechanical refrigeration offers probably the most universal field for the application of an oil engine, and for this reason it behooves every refrigerating engineer to post himself on the various types of engines and the proper method of installing and operating them. It is a coincidence that in the most rapidly growing sections of our country, as far as the refrigerating industry is concerned, namely, the South and West, oil is the fuel most available. However, the fuel economy of practically any type of oil engine is such, and the fuel-oil distributing and marketing systems have been improved to such an extent, that a great many installations are being made in sections remote from the oil-producing territory.

The development in methods of raw-water ice manufacturing has tremendously increased the possibilities for oil engine power. Even at points where the characteristics of the water have so far resisted the skill of the water-treating expert, evaporating plants of high efficiency employing three- or four-effect evaporation and furnishing distilled water at a cost of approximately 50c. per ton with $1.50 oil, can be installed, enabling even those plants situated in such unfortunate territories to get the economical power of the oil engine.

No Mystery About the Engine

The inexperienced oil-engine operator, even though having had years of practice in steam-engine operation, is inclined to be superstitious to some extent as far as his relation with his new engine is concerned. Its action and inaction are at first unexplainable by any laws of the universe. As a matter of fact, and as this engineer comes to realize sooner or later, the oil engine is one of the most beautiful examples of logical cause and effect in the realm of mechanics. The engineer must master the fundamental principles of the particular type of engine that he is operating as, with the exception of purely mechanical problems common to all types of machinery, the performance of the oil engine, on analysis, will trace back in nearly every instance to these fundamentals.

Having mastered the fundamental principles of his engine and become acquainted with its operating characteristics, the operator soon learns that its successful and dependable operation depends largely and primarily on five things, assuming that the type of engine installed is suitable for the service and has been properly installed. These five factors are: (1) Proper loading; (2) suitable fuel; (3) correct lubrication; (4) ample and dependable supply of non-scale forming cooling water; (5) a systematic operating and maintenance schedule with properly kept records.

Probably the unreserved acceptance of the reliability and low cost of upkeep of the oil engine by the refrigerating industry and others, has been delayed longer by the disastrous results of the improper loading of the great majority of the earlier installations than by any other one thing. In order to meet competition the engine manufacturer finds it almost compulsory to rate his engine at a high mean effective pressure. As temperatures in the oil-engine cylinder, high as they are under moderate load conditions, increase with an increase of the mean effective pressure, it is apparent that internal conditions may become very severe when operating continuously at high rating.

Best Engine Load

It has been demonstrated that for continuous service a load of not over 80 per cent of the engine rating will permit the most satisfactory performance with long life and low upkeep. The oil-engine-driven pumping stations of the larger oil-pipe-line systems in which this per cent loading is customary, are excellent examples of the reliable operation obtainable under such conditions. Many of these engines in this service have averaged over 99 per cent of operating time for a period of several years. European practice is somewhat more conservative, 75 per cent loading being usual for continuous service. Except in unusual cases the difference between 80 per cent and 90 per cent load continuously will mean the difference between a successful installation and a failure.

This loading not only applies to the loading of the engine as a unit, but in the case of multi-cylinder engines it applies to the loading of each cylinder. For this reason great care must be exercised to insure that the load is equally divided between the cylinders. This balancing can be checked approximately by removing plugs or opening test cocks in the exhaust of each cylinder and adjusting the fuel pump so that the noise of each exhaust is equal. The use of pyrometers is much more accurate. Its installation in the exhaust of each cylinder will indicate much as to the general condition of the engine.

Kind of Fuel To Use

There are some engines built that will burn any liquid fuel capable of being pumped. There are other types that are limited strictly to the lighter distillates, or so-called "gas oils." In between there are many types operating best on certain classes of fuels. The fuel most available in the location of the plant should be thoroughly considered when selecting the engine to be purchased. In any event the oil must be free from grit and water, or must be handled and stored in such a way that these substances will be settled or screened out of the fuel before it goes to the engine. This may necessitate the installation of double storage tanks, which can be easily drained or in which heating coils may be installed.

In most locations the insurance requirements demand that these main storage tanks be installed below the level on the engine room so that a forgotten valve or

*Extract of paper read before the National Association of Practical Refrigerating Engineers, New Orleans, La., Nov. 13, 1924.

broken pipe will not flood the building with a combustible. The ideal is to install two steel tanks in a concrete pit which will permit inspection and repair of leaks. Old tanks from tank cars are an economical purchase for this purpose, as such tanks, when well calked, are serviceable in a stationary installation long after their usefulness in railroad service is passed. A day tank is usually installed in or near the engine room, which should be arranged for easy inspection and measurement of the fuel.

Heating the Fuel

It may be necessary to heat the fuel to enable the pumps to handle it. On one trouble job recently, where some difficulty was experienced in burning a heavy crude oil, it was found that heating with the jacket water from the engine up to 135 deg. F. gave results equal to those when using a mixture of half crude and half kerosene. Some of the larger stations are now passing the fuel oil through centrifugal separators to insure elimination of water and other impurities. In general, an engine employing gradual combustion, or combustion at constant pressure, as in the Diesel type, will operate best with a comparatively slow-burning fuel. An explosion-type engine, or one in which there is comparatively low compression and combustion occurs more or less at constant volume, requires a more flashy or quick-burning fuel.

There is, of course, much argument as to the advantages and disadvantages of asphalt-base oils for cylinder lubrication as compared with parafin base-oils, and there may or may not be merit in the respective claims. Engine manufacturers rarely express a preference, although they are ready to specify limits of viscosity under certain temperatures. One manufacturer of two-stroke-cycle high-compression engines specified that oil used in the cylinder should have a viscosity of not less than 450 Saybolt seconds at 100 deg. F. A well-known manufacturer of paraffin-base lubricants recommends for this same engine an oil having a viscosity of 470 Saybolt seconds at 100 deg., while an equally well-known manufacturer of asphaltic lubricants offers and recommends an oil having a viscosity of 750 Saybolt seconds at 100 deg. It is pretty safe to assume that oil satisfactory in a two-stroke-cycle engine will be satisfactory in a four-stroke-cycle engine, so that the limitations enumerated can be applied to nearly all types of engines and lubricants.

A Good Water Supply Needed

In the great majority of plants water is too costly to be wasted after leaving the engine jackets, and independent cooling systems or, rather, recooling systems are necessary. These systems, though simple, must be absolutely reliable. Failure of the water results in the most expensive of all damages, for cylinder heads and cylinders crack quickly, pistons seize and cylinders score with no warning if circulation stops.

Equally as important as a dependable supply is that the water does not deposit scale in the engine jackets. Scale accumulation will cause cylinders and cylinder heads to crack and will greatly increase the water on cylinder bore and piston rings, as it retards the flow of heat from the cylinder walls to the jacket water. In some instances scale deposit can be prevented by circulating enough water through the engine to prevent any large temperature rise in the water. Contrary to a surprisingly widespread belief, scale-forming water does not lose its scale-forming properties by being used over and over again. Scale will really be deposited at an increasing rate due to concentration by evaporation. Scale-forming water can be made suitable for oil-engine cooling only by treatment with chemicals. Correctly treated water will remain clean and free from moss for an indefinite period. Where water requires such treatment, the cooling system should be filled with treated water, not raw water. All makeup water should be treated before it is added to the system. The correct selection and proportion of chemical is, of course, of greatest importance.

If scale has already formed on the jackets, the proper chemical can be secured by sending a specimen of the scale to a chemist for analysis. A muriatic-acid solution has been used widely for this same purpose, although less expensive chemicals can be obtained. In case the available cooling water is salty to any extent, scrap zinc in the water jackets and piping system will prevent electrolytic action.

In figuring cooling water, assume from five to eight gallons of water per horsepower-hour for a four-stroke-cycle engine, and eight to twelve gallons for a two-stroke-cycle engine with temperature range of 50 deg. and approximately ten gallons per day per horsepower for evaporation makeup.

In handling the jacket water all operators should be cautioned against following their natural inclination to give more water as the load comes on. The circulation should actually be reduced slightly to permit the cylinders to warm up and expand with the rapidly heating pistons and then be gradually increased. Increasing jacket circulation as the load comes on is likely to cause a seized piston. Never turn cold water into a hot engine or vary the temperature of the jacket suddenly, as damage may result. The circulation should be continued for ten or fifteen minutes after the engine is shut down in order to carry off the stored up heat from the interior.

Making the Plant Successful

The most successful oil-engine plants are those operated on a definite operating and maintenance schedule or calendar, with complete records kept not only of routine observations, but of adjustment and wear as well. By such schedule an engine is operated for a certain number of hours per week or per month and shut down for a certain number of hours for adjustment and repair, somewhat on the old principle of the Saturday night bath as something to be taken whether it is needed or not. A spare unit in an ice plant during the hot season is an unheard-of thing, and the object of the schedule in such plants is to operate all units the greatest possible number of hours per season.

A shutdown of one hour per week or two hours every two weeks might be considered good practice for some types of engines, while others might require more frequent stoppage or a longer shutdown period. Many engines could probably run without stopping for the entire length of the season. An engine at Horton, Kan., for example, was recently reported to have operated for over two hundred days, or approximately seven months, without shutdown. To try this in an ice plant would be taking serious chances of a long shutdown, which, coming at midseason, might be disastrous. With a well-organized crew and an ample stock of spare parts a great deal of work can be done on an engine in one or two hours, and this practically insures continuous

service until the time of the next scheduled shutdown.

The maintenance schedule should start with a thorough overhauling of the engine after the close of the season of heavy demand or in ample time before the start of the following season. The most important of all operations at this time is the positive checking of the mainshaft for misalignment. This done and assuming there is no setting in the foundation and that the lubrication during the season is correct, there need be no fear of a broken crankshaft.

Pistons should be removed, rings thoroughly cleaned or replaced if necessary, cylinders examined for scoring, and accurate measurements taken of cylinders and pistons with permanent record made of findings. All bearings should be examined, cleaned and scraped if necessary. All valves, including all spares, should be ground or faced and ground. Jackets should be thoroughly scaled. Fuel pumps must be cleaned and repacked and all check valves made tight. The timing of all valves should be checked accurately and permanent record made of same. Cams, rollers and bushings should be inspected carefully and replaced if worn. If it be an air-injection engine, the compressor should also be gone over.

If these operations are performed thoroughly and accurately each year before the start of the season, the weekly or bi-weekly maintenance will consist principally of inspection and taking up of the bearings where needed, checking the valve timing, balancing cylinders, together with the replacing of exhaust inlet, fuel and compressor valves with spares at regular intervals, according to the service.

Closely related to a systematic routine of inspection and maintenance is the daily log sheet. The usual hourly observations of jacket temperatures, speed, pressure of injection air, pressure in the lubricating oil system, fuel and lubricating consumption, etc., are necessary to insure these points being observed by the operator on duty as well as to record the performance of the engine. It would be well to add to these log sheets a column for temperature of exhaust from each cylinder and to equip the engine with exhaust pyrometers in order to secure this information. The log should have space available for notes on adjustments or repairs which may be transcribed to a more brief and permanent record.

Steam Tables Differ Widely

At the meeting of the Steam Table Fund on Dec. 4, 1924, during the annual meeting of the A.S.M.E., George A. Orrok, chairman of the Executive Committee, distributed some interesting diagrams, two of which are reproduced herewith.

If any argument were needed for steam-table research, these diagrams would supply it. Fig. 2, showing the variation with pressure of the total heat of saturated steam is particularly illuminating. It will be noticed that agreement is close up to about 100 lb.; at 200 lb. the extreme divergence is about 10 B.t.u., or a little less than one per cent. At 500 lb., which is today a commercial pressure, Schüle gives the total heat as 1,228 B.t.u., Callendar as 1,221, Marks and Davis as 1,210, Knoblauch and Stodola as 1,204 and Goodenough as 1,202. Stodola's old curve need not be considered.

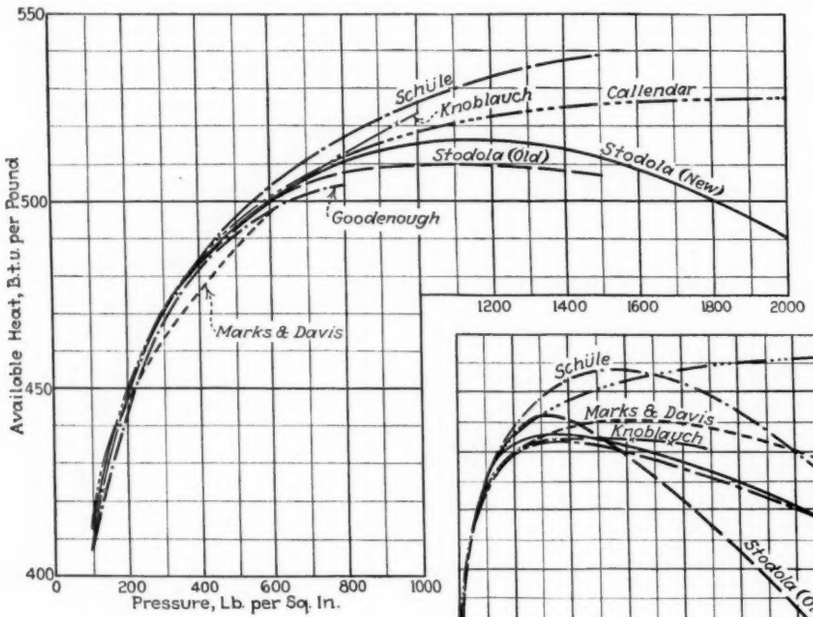


Fig. 1 (Above)—Heat available, expanding from 700 deg. total temperature to 29-in. vacuum

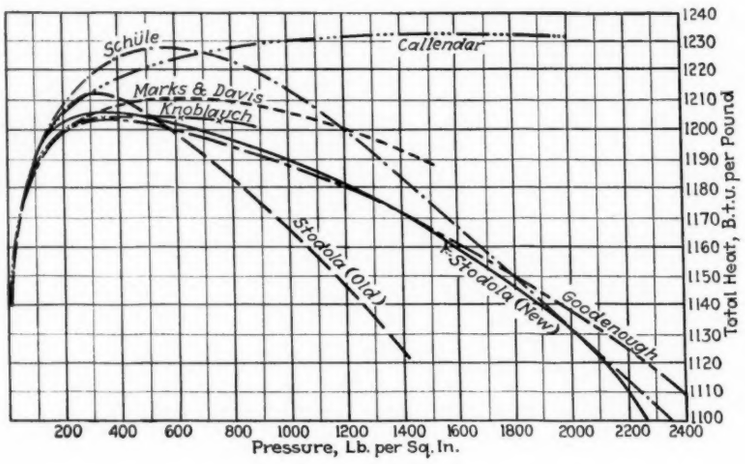
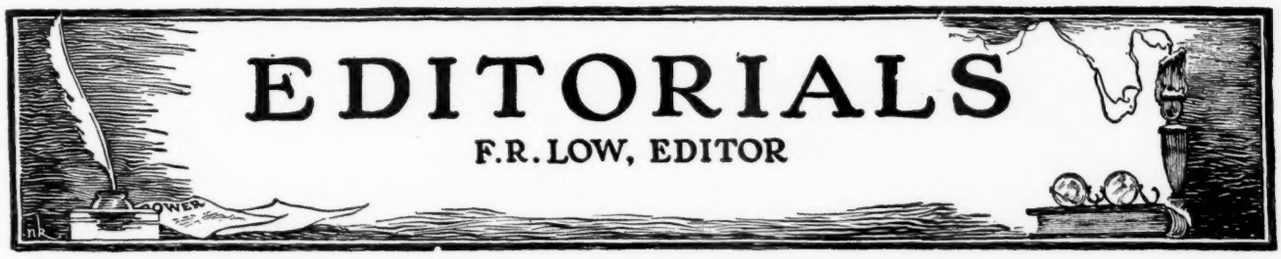


Fig. 2 (Right)—Total heat of dry saturated steam

It seems generally agreed that the total heat reaches a maximum and then falls off. This appears faintly in the Callendar curve at a pressure around 1,600 lb. In round numbers Stodola places the maximum at 300 lb., Goodenough at 350, Schüle at 550 and Marks and Davis at 650. With one plant nearing completion for 1,200 lb. pressure and with several being constructed for pressures around 500-600 lb., designers are asking who is right. The steam-table research now in progress at the Bureau of Standards, Harvard and the Massachusetts Institute of Technology, is expected to give a definite answer to this question. The divergencies in available heat, as shown in Fig. 1, are numerically much less than those in Fig. 2, but are nearly as important when reduced to a percentage basis.



A Co-ordinator of Science and Engineering

THE American Association for the Advancement of Science, whose annual meeting was recently held in Washington, gives promise of becoming a highly important factor in the promotion of civilization not only in America but throughout the world. It is now generally recognized by intelligent people that advance in the common welfare is absolutely dependent upon the applied sciences: engineering, medicine, applied economics, etc. These, in turn, rest on a basis of pure science. Medicine gets nowhere without a background of research in zoology and physiological chemistry. Engineering, in turn, is based on many sciences, among which physics, chemistry and economics are prominent.

On the other hand, the pure sciences are indebted to the applied sciences for their livelihood if for nothing else. It is the practical results that justify pure science in the popular eye and insure the necessary financial support. The growing appreciation of mutual dependence is resulting in better co-operation and a finer appreciation of the other men's problems and contributions.

It was for exactly this purpose that the American Association for the Advancement of Science was founded. There are *exclusive* organizations that exist to honor the brilliant few. This association is *inclusive*, designed to bring together all who are interested in any scientific field.

Workers in the power field have some direct benefits to expect from such an organization. One is the encouragement of a joint attack upon the problem of energy resources and transformations. As the retiring president, Charles D. Walcott, said in his presidential address, "To make an inventory of future energy supplies of the world would require co-operative study by geologists, chemists, physicists, engineers, biologists and sociologists." Human muscle is a power plant which turns the energy of food into mechanical work. At this very moment intensive study is being applied to the chemical changes that go on in a muscle during exertion. It is not beyond the bounds of reason that such work may some day have a significance in power production. The same applies to the work of the physicist in connection with the structure of the atom, that of the geologist on the location of mineral fuel, etc.

Geared Turbines With Close Clearance for High Pressures

ABOUT two years ago turbines for pressures around one thousand to two thousand pounds existed only as possibilities and their probable constructions were matters for conjecture. There are now many designs developed for high-pressure elements of this character, with distinctive features awaiting the test of commercial service.

Since friction losses vary approximately as the density of the steam inside the unit, impulse turbine designs here and abroad quite generally employ small disk diameters. Low steam velocities are desirable on account of the erosive tendency of the heavier steam and also, as claimed in some quarters, for better blade and nozzle efficiencies.

With impulse machines, however, there appears to be a future for general high-speed units. In order to reduce disk diameters to the minimum at rotative speeds now fixed by alternating-current generators, a large number of stages are required. Since the energy absorbed in a stage per pound of steam varies as the square of the blade speed, cutting in half the disk diameter would require four times the original number of disks, at the same rotative speed.

An alternative to providing so many stages lies in increasing the rotative speed. As pointed out at the World Power Conference, a high-pressure impulse turbine for two-thousand-pound steam, in order to have approximately the same losses as a similar unit at two hundred pounds, should operate at about three and one-half times the rotative speed of the lower-pressure unit. Since the loss in gearing is not large compared with other turbine losses, it is possible that geared machines of high rotative speed will become commercially justifiable.

Close clearances, both axial and radial, between rotating and stationary elements appear to be characteristic of high-pressure designs. It is known that the pumping action of disks on the steam can be restricted by this means, and the more general application of this feature is to be expected. Rigidity of the rotor therefore becomes highly important, being favored by higher rotative speed and fewer stages.

Public Utilities and Politics

THERE has been a notable tendency during the last year toward the organization and financing of large holding companies for public utilities and also of companies for the purpose of buying large blocks of the stocks of public utilities and thereby influencing their financial policies. This tendency can be viewed only with the gravest concern by those who have the good of our public utilities at heart. Generally these holding companies have been organized by financial interests whose chief concern is the money to be made rather than the relations of the utilities with their customers. Such interests are therefore fundamentally opposed to sharing gains with consumers in the form of reduced rates.

Twenty years or so ago the same game was played with the railroads. The politicians, finding the railroads in disrepute with the public, used them as a football to further their own interests. The restrictive measures imposed on the railroads by legislation have proved a heavy burden which all but wrecked our trans-

portation systems. Only in recent years have the railroads been somewhat relieved and been accorded fair and reasonable treatment. In the meantime the public suffered from poor and often inadequate transportation service at high rates, while investors suffered from lack of dividends.

The public are not asleep to abuses that may creep into the organization of our public utilities. Even today there is much loose talk in the State of New York of the public development of its water powers. The Hydro-Electric Commission of Ontario, in spite of certain shortcomings and all that has been said against it, has achieved a large measure of success and gives cheap service to its customers. Many far-seeing utility executives have cut rates from time to time as profits in the business warranted it. The public knows these facts, and as electric and gas services become more and more essentials of life, greater interest will be taken by the public in their administration and policies.

Everyone recognizes the fact that interconnection of power systems into a network is frequently an economic advantage and that it is right that companies should agree to interchanges of power. The merging of many small companies into one large system is also justifiable on the basis of better and cheaper service. However, the public will soon find means of combating those concerns that are organized solely to draw tribute from them over and above a fair return on the investment in the service. Only the other day one of our Senators charged that an electric trust had already been formed by one of the large electrical manufacturing companies.

The danger to the public utilities lies in the probability of the politicians attacking them as they did the railroads and, by restrictive legislation, halting natural development of these public utilities for many years. This situation is not pleasant to contemplate. Furthermore, it may be avoided. Those in charge of our public utilities have shown courage and faith in the public in the past. If they will disavow the activities of these predatory interests that would bring about their downfall, such action would have a far-reaching effect in restoring that public confidence and mutual good will which in the end is the only assurance of progress and profit to all concerned.

Making a Success of a Diesel Engine Plant

OCCASIONALLY, the remark is made that a Diesel engine is difficult to operate, subject to many troubles and expensive to maintain in working condition. While this represents actual conditions prevailing in a few power plants, in general the modern Diesel situation is completely successful and has a maintenance cost that is surprisingly low.

Not long ago two power plants belonging to rolling mills were visited. These plants were equipped with identical Diesel engines, built the same year, running at the same speed and under similar load conditions. In one of the plants the engine stood in a deep, dark and dirty pit. Most of the window panes in the building were broken, admitting rain and dust; the crankcase doors of the engine were missing; all bearings were loose and pounding. In short, the whole installation showed indifference on the part of manager and neglect on the part of the operating crew. The engineer complained bitterly about the engine and in answer to a question stated that he did not know anything about the machine. It is not surprising that a power plant with such indifferent attendance is expensive to maintain and subject to many forced shutdowns.

The other plant was bright, roomy and clean. The engineer, who had operated the engine since the day it was first started about ten years ago, kept it in good repair and operated it intelligently. He took pride in his engine, and the owner of this mill could not praise the power plant too highly.

Here is an instance of two engines, exactly alike and running under nearly identical load conditions, one a failure and the other a complete success, due entirely to the manner in which the units were operated and taken care of. There is no doubt that a careless operator will have troubles with the best-designed and constructed Diesel engine, while a good operator will be reasonably successful with one poorly designed.

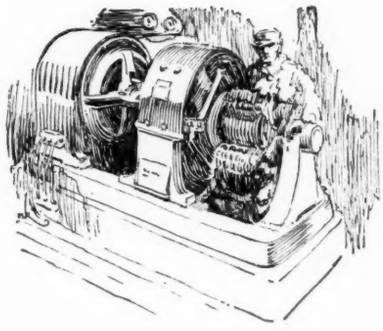
Nearly all operating engineers like to make a success with the machinery entrusted to their care, because it is to their own advantage to keep the engines in good running order. Similarly, most owners are only too glad to equip their power plants with the needed apparatus so as to secure low operating cost and avoid shutdowns and expensive repairs. The reason why some engines are not properly taken care of is generally a lack of understanding on the part of the operating engineer, as well as of the owners not knowing what apparatus is actually needed and what care the engine demands. There is in reality no difficulty in operating a modern Diesel engine successfully if the power plant is properly equipped and the operating engineer knows what to do and what to avoid.

The causes of perhaps ninety per cent of all the troubles that occur with Diesel engines, are either insufficient cooling, improper lubrication or poor combustion. Good results cannot be expected from the engine unless adequate cooling and lubricating systems are provided and fuel oil of a certain quality used. The owner should not expect his operator to show good results if he has failed to furnish the needed apparatus and materials. The owner should further understand that a Diesel engine requires periodical minor adjustments and repairs, and the engineer should be given opportunity to do this work.

Following out a schedule of inspection such as one gives any high-grade machine, will result in a reliability and economy of operation that will justify the slight additional labor involved. There can be no justification for the neglect that the engine so often experiences.

Everybody knows that freight is a large fraction (often more than half) of the cost of coal. While the time may never come when fuels can be selected solely on the basis of the cost per million B.t.u. delivered at the plant, that condition is a limit that is being continuously approached—as our mathematical friends would say. Stokers are now available for the efficient utilization of practically all varieties of coal, including lignite. The advent of pulverized fuel has gone farther toward equalizing the value of a million B.t.u. delivered in various fuels. All this means a growing tendency for coal users to obtain their fuel from the nearest field. With proper reservations this means not only lowered costs in power generation, but a more economic utilization of the country's railway facilities.

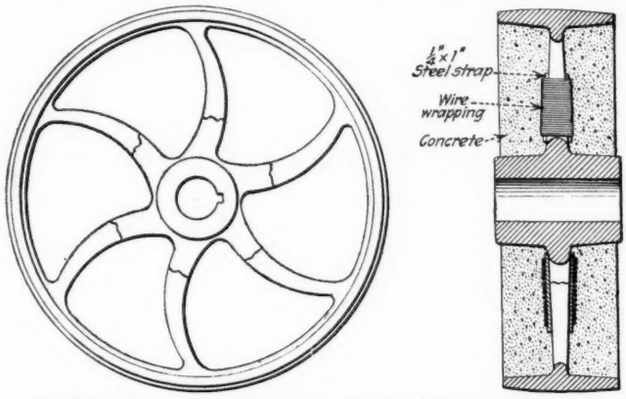
Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. Three prominent operating engineers have been invited to act as judges. The winners will be announced the succeeding month.

Portland Cement Used in Making Repair to Thirty-Six Inch Pulley

Not infrequently, engineers are called upon to make some temporary repair in order that the plant may be kept in operation. Portland cement may be utilized to make some of these repairs, and while its low value of strength, as compared to iron or steel, prevents its being



Spokes were stayed and wrapped with wire then the whole filled with concrete

depended on for positions of tense stress, it has the necessary strength to hold parts in place so that their own shape will take the strain.

Recently, in attempting to remove a 36-in. pulley we were unfortunate in breaking the six spokes of the wheel. For an experiment and as a chance of gaining some time, we decided to make a repair with common cement by filling the whole with a mixture of 1 to 4 cement and river sand. As the hub had not been moved on the shaft, the rim with the spoke portions was replaced and trued to position. Then steel straps ¼x1 in. were placed on each side of the spokes and tightly wrapped with wire to hold the parts in place. Boards were then placed up the sides of the wheel as the cement mixture was poured and tamped to every corner until the whole wheel was filled. This was left standing from Saturday noon until Monday morning when the boards were removed and the machinery started.

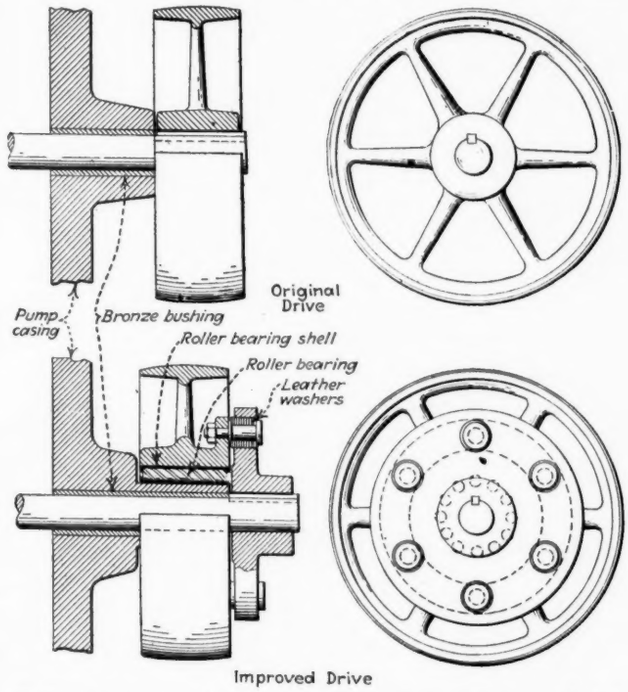
The speed of the wheel was 200 r.p.m., and while we avoided its vicinity, rather expecting the uncured cement to fail, we were agreeably surprised to find that it did not go to pieces, and it is yet intact, although we replaced it with a new wheel a week later.

North Bend, Neb. G. G. McVICKER.

Change Made in Pulley Drive to Eliminate Belt Pull on Shaft Bearings

Some time ago I designed a rotary vacuum pump, in which the rotor was made a very close fit inside the housing. The shaft on which the rotor was mounted ran in bronze bearing in the pump housing, and the driving pulley was mounted on the rotor shaft close to the bearing, as shown in the upper part of the illustration. The pump worked satisfactorily for a time, but the pull of the belt caused the bearings to wear to one side, allowing the rotor to be drawn out of alignment with the pump housing, causing it to bind.

This trouble was overcome by casting a larger hub on



Pulley was mounted on roller bearing and connected to shaft through flexible coupling

the housing and machining it on the outside, concentric with the shaft bearing, and mounting the pulley on this hub as shown. In this particular instance a roller bearing was used, although in some cases a ball bearing may be preferable. The pulley was connected with the shaft by means of a flexible coupling mounted on the end of the shaft as shown in the illustration.

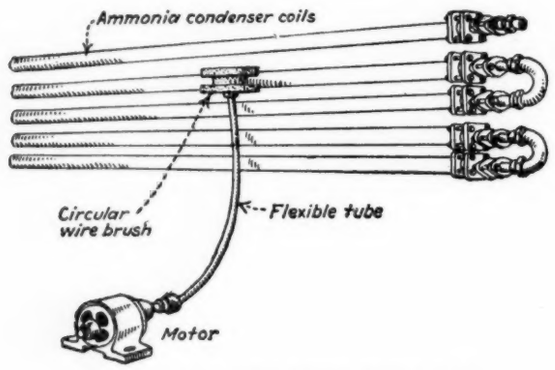
This arrangement transfers the pull of the belt from the rotor shaft and bearings to the hub on the pump casing. This has proved to be a satisfactory drive, and I see no reason why the same idea could not be used in many places such as on electric motors, small generators, etc., where belt drives are used.

This idea may be an old one, but as I have never seen it in use, I am passing it along for what it is worth.

Mankato, Minn. R. A. KAPLAN.

Cleaning Condenser Coils

One of the most disagreeable jobs around a refrigerating plant is the cleaning of the condensers. Where double-pipe units are used, the job of removing the scale from the inner pipe by means of a rotary tube cleaner is not difficult, outside of the removal of the



Motor-driven wire brush cleans coils

end connections. With the atmosphere type the scale deposits, of course, on the outside of the pipe and, so far as I have observed, always is removed by a chisel or by the use of a flat wire brush. Both of these meth ods call for a lot of hard labor.

Recently, one of my men, in trying to avoid hard work, developed a scheme of using three circular wire brushes arranged as shown in the sketch. He fastened the brush assembly to a flexible shaft taken from a horse-clipping machine. The shaft was then coupled to a ½-hp. motor.

The illustration shows how the apparatus was used. The brushes were wide enough to remove the scale from one half of a coil, after which the other side of the coil was cleaned. The time required to clean a stand was reduced by at least 75 per cent, and the men no longer allowed the scale to accumulate for weeks at a time. G. GROW.

S. Louis, Mo.

Eliminating Liquid Ammonia from the Suction Line

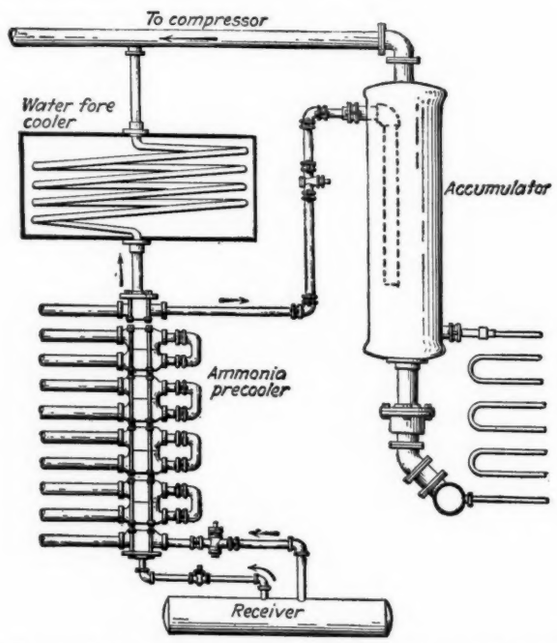
We always had trouble in preventing leakage at the piston-rod stuffing box, and our remedy for this trouble may interest other engineers.

The refrigerating plant was equipped with a gravity-feed flooded-coil evaporating system and a vertical single acting compressor. The accumulator of the flooded system was supposed to catch all the liquid, so that the suction gas going to the compressor would be dry or superheated a few degrees.

Unfortunately, we found that the accumulator failed to dry the suction vapor and the liquid carried over to the compressor kept the rod so cold that its diameter was enough less than the diameter at ordinary temperatures, so that the stuffing box leaked. Of course we could offset this more or less by screwing up on the gland when the rod grew cold after starting. The objection to this was that the accumulator action was irregular and, after passing liquid for a time, would proceed to catch all liquid, the vapor reaching the machine superheated a trifle. This meant constant readjustment of the piston-rod stuffing-box gland.

To eliminate this bother, we installed in our ice-storage room a double-pipe cooler. Ammonia from the receiver was passed through the outer pipe on its way to the coils, and a line was run from the liquid receiver to the inner pipe with an expansion cock between the receiver and coil. The ammonia, on expanding in the inner pipe, cooled off the liquid ammonia in the outer pipe, acting as a forecooler. The expanded vapor was then passed through coils in the water precooler and then entered the suction line.

By suitable regulation of the forecooler expansion cock the temperature of the forecooler suction can be regulated at will. If the accumulator is passing enough liquid to cause the suction line to frost up to the com-



Connecting up forecooler and precooler to dry out the suction vapor

pressor, the forecooler expansion coil is adjusted to cause the gas leaving the water cooler to be slightly superheated, and as a consequence the frost recedes from the compressor connection. In practice the apparatus behaves satisfactorily. By having the forecooler in the ice storage, there is no loss of refrigeration by heat absorption from the atmosphere, and the coils in the water precooler lower the water temperature to any desired temperature. G. GROW.

St. Louis. Mo.

According to H. C. Porter, for low-temperature distillation to pay, products totaling about one-half cent in value must be obtained from each pound of coal costing one-quarter cent.

Comments from Readers

Hollow Walls Employed for Air Preheating More Than Thirty Years Ago

In reading the articles on the various methods of combustion control and air preheating that have appeared recently in *Power*, I am reminded of an installation of air preheating that is more than thirty years old.

About two years ago, when removing a battery of five horizontal return-tubular boilers that had been installed in 1890, our attention was attracted to a cast-iron door in the bottom center of each bridge wall. This door had apparently been put in when the boilers were first installed, but had later been bricked over.

Upon investigation it was found that each bridge wall was hollow and that all were connected together through the side walls by an opening of the same size. On removing the firebrick lining of each furnace, it was apparent that openings or ducts had been provided originally, in the side walls at about grate level to connect the ducts in the bridge walls with openings louvered on the boiler fronts.

Each furnace wall had long since been built up solid and the opening to the space in the bridge walls closed up. The louvers or slotted covers on the boiler fronts had been noticed, but had been considered a form of ornamentation. No one connected with the plant knew of this arrangement or if it had been satisfactory.

Anderson, S. C. WILLIAM J. LIGON.

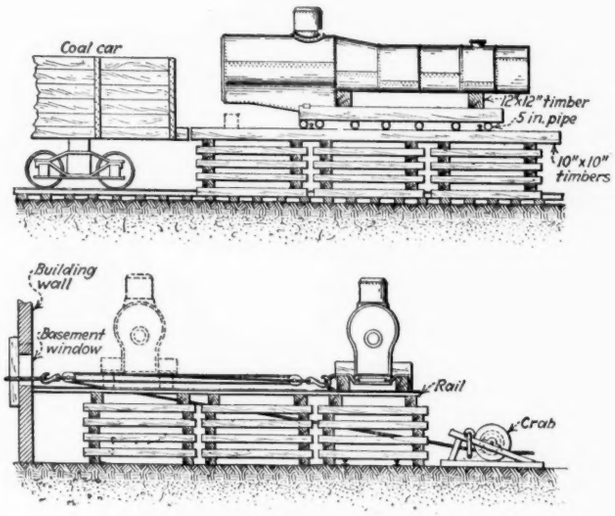
Unloading and Placing a Sixteen-Ton Locomotive Boiler

The article by H. W. Price in the Nov. 18, 1924, issue entitled "Unloading and Placing a Nine-Thousand Square-Foot Condenser" recalled a number of rigging jobs that I have had charge of at different times. A brief description of one of these is given herewith.

In the operation of our plant it became apparent that we needed a large heater to heat water for process work. As we could secure a discarded locomotive boiler that had been stripped of all the fittings but was still in a fairly good condition, we decided to buy it and set it up. We planned to seal up the bottom of the firebox and pass exhaust steam through the firebox and tubes and circulate the water through the boiler proper.

We ordered the boiler shipped to our plant, and upon its arrival we found it was in a coal car instead of a flat car as we had expected. As a switch engine called at the plant twice daily to switch in and take out loaded cars, it was necessary that the boiler be unloaded as quickly as possible so as not to interrupt the switching operations. The day it arrived we prepared the skids and put them under the boiler. We put a large timber under the rear end of the firebox as shown dotted in the upper view, then jacked up the front end and put the rollers and timbers in position, then by placing two 12x12-in. crosspieces below the boiler as shown and letting down the front end, it rested on the skids raised away from the blocking under the firebox. Heavy chalking pieces were wedged in between the crosspieces and the boiler before the entire weight was let on the skids, to prevent the boiler from turning.

The crosspiece in front of the firebox was almost at the balancing point, so we made two hangers from 1x3-in. flat iron and fastened them to the top of the skids with lagscrews, the other end of the hangers being hooked into the firebox. The boiler was blocked in this position in the car overnight by nailing small chalks on both sides of the rollers and by braces between the boiler and the sides of the car. This precaution was necessary so the switching operation during the night would not jar it loose. The next morning we



Cribbing and tackle used in unloading locomotive boiler

removed all the braces and chalks and built up the cribbing and started the boiler out of the car by pulling it with rope blocks attached to a crab. We also attached a block on the rear end for a snub.

After the boiler was out of the car, two more tiers of cross-tie cribbing were erected, and two railroad rails with their tops greased were placed upon them between the rollers as shown. Then the boiler was jacked up, one end at a time, and the rollers were taken out and the skids lowered onto the rails.

A set of blocks and crab was attached at each end to pull it sideways on the rails. The boiler was moved over until it was over the last tier of cribbing, as shown by the dotted lines. As it still had to be moved ahead about ten feet, it was jacked up again, the rollers replaced and the rails removed. The first two tiers of cribbing were then taken down and the track cleared for the switching operation. After the boiler was in the proper position, it was blocked in place and concrete footings erected. A. A. FETTE.

Cincinnati, Ohio.

An Ancient Indicator

I was much interested in the description of the ancient indicator, now in possession of Lehigh University, as given in the Nov. 18, 1924, issue.

The accompanying illustration, Fig. 1, shows the details of an indicator owned by the Plymouth Cordage Co., North Plymouth, Mass., which is apparently similar to the one at Lehigh University. It is made of brass except for the spring, a part of the pencil arm and the scale for indicating the pressure, which are of steel.

Fig. 1—Ancient indicator

The paper drum is adjustable vertically and circumferentially by means of a clamp. The pencil arm is hinged to facilitate removal from contact with the card and is held against the card or away from it by means of a flat spring which operates in much the same manner as the spring and blade of a pocket knife, which arrangement is familiar to everybody.

Fig. 1 shows the pressure scale screwed to the side of the barrel which incloses the cylinder and piston. The cut also shows a steel point extending out to the scale, by means of which the pressure in the cylinder is indicated. The whole instrument is in an excellent state of preservation, and the fittings include a tap for tapping the engine cylinder to receive the angle cock by means of which the indicator is attached to the engine. The indicator barrel bears the inscription "Novelty Iron Works, New York," No. 6, no date being given.

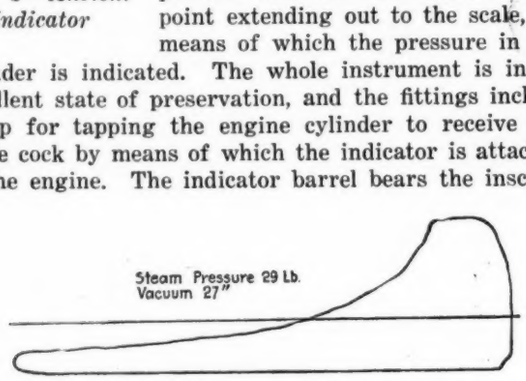


Fig. 2—Diagram taken with indicator shown in Fig. 1 Oct. 30, 1861

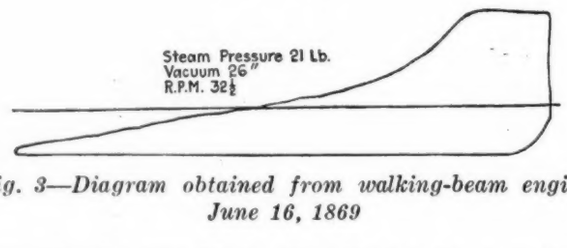


Fig. 3—Diagram obtained from walking-beam engine June 16, 1869

The diagrams shown in Figs. 2 and 3 are reproductions of the original diagrams which are still in the box with the indicator. Fig. 2 was taken in 1861 from a vertical "walking-beam" engine which was destroyed in a fire in the late sixties. The other diagram, Fig. 3, dated 1869, was obtained from another "walking-beam" engine which is still in place at the Plymouth Cordage Works although it has not been used for several years. The indicator must have been in existence since the late fifties.

C. B. HUDSON.

North Plymouth, Mass.

Fitting Piston Rings by Peening

I read with interest the contribution by J. R. Belknap, in the Nov. 18, 1924, issue entitled, "Fitting Piston Rings by Peening," and while agreeing with a good number of his views, he states that he has had very little luck with peening, an operation I am sure that is almost as old as piston rings.

In the early stages piston rings no doubt were turned out as suggested by Mr. Belknap in his sketch, Fig. 1, the workman filing and peening until he obtained a perfect fit, but with improved methods of machining this practice was discontinued many years ago, and peening is resorted to only in the case of worn rings of the snap type that have "lost their tension." Not only is this done on small rings, but also on those from 24 to 36 in. in diameter. My method of peening is to work upon the ring directly opposite the split, laying it upon a curved or rounded surface and hammering the inside of the ring lightly. By careful manipulation almost any desired tension can be obtained and a new life given to the ring.

Of course all up-to-date engineers realize that rings can be obtained today at a low cost that are machined inside and ground to outside diameter after removing the necessary amount at the split to provide a good tension, so that peening becomes only a makeshift. The process of peening should appeal only to the man in isolated places or to those who have to take out pistons to obtain dimensions for new rings, when a little peening may save a few tons of coal until the new rings come along. When they arrive and are found satisfactory, spares should be ordered at once before the sizes are mislaid or forgotten.

Writing upon this subject recalls an interesting experience that occurred more than thirty years ago and which demonstrated what a resourceful engineer can accomplish. I was employed in a shop a few miles from Glasgow, and we had an order for replace rings from a Glasgow publishing house, the arrangement being that two men should be sent at 6 p.m. on a Saturday to fit the rings in place. So one fine Saturday Sandy and Jock were dispatched for the job. As our shop closed at noon, they had lunch and then started on the short journey with about five hours to spare. Both Sandy and Jock, like most good workmen of that time, had a weakness for partaking of the "Wine of the Country," and despite serious warning from the old manager on this point, they arrived at their destination promptly to time but minus the rings. Each thought the other had them, and so many calls had been made on the road that neither had the faintest idea where they might be found. It was then that Sandy took the matter in hand. The old fireman let them in and immediately left them alone while he went home for a "bite." During his absence both worked their hardest, and when he did return Jock met him at the door and suggested "having one" across at the corner, an invitation which the old fireman, being a Scotsman, readily accepted, and Jock saw to it that he did not return until Sandy had the old rings peened and in place, after which they all three returned to the corner aforementioned and all was satisfactory.

During the next few days Sandy was ill at ease, particularly every time the old manager came near him. Then he saw him approaching with a letter in his hand which he took for his death warrant, but his fears were groundless. The letter, which had contained the

check for the new rings, stated that they had already made sufficient saving in coal to cover the cost and they were delighted at the way the work had been carried out. Two years later Jock and I had the job of fitting another set of rings, and while doing so Jock told this story. It would have been difficult at that time to convince him that the peening of piston rings does not save something else besides steam. F. P. TERRY.

Belfast, Ireland.

An Experiment in Boiler Setting

I should like to make a few comments on the article by A. A. Fette in the Sept. 30, 1924, issue, entitled "An Experiment in Boiler Setting."

The designing engineer should always bear in mind that the satisfactory performance of any particular piece of equipment depends upon the person or group of persons who operate it. It is important that any part that may fail can be replaced without disturbing too many other elements. This requirement is not fully met in the experimental setting, as it would be difficult to roll or bend tube ends properly in the combustion chamber. It is manifest that the chief object in placing the baffle wall in the combustion chamber was to obtain better distribution of the gases.

Out of the accumulated experience of boiler builders has come a fairly good understanding of what are the main items to be considered in employing the heating surface of a boiler. The effectiveness of the heating surface in the experimental setting is undoubtedly destroyed by the creation of pockets within the combustion chamber in which large quantities of soot and fine ashes will accumulate. Where a pocket exists, gas circulation within the pocket is of low velocity and any means taken for blowing out the soot becomes more or less ineffective, because the gases moving slowly permit the soot to fall back after being stirred up. Where the gases travel at high velocity, there is no special difficulty in removing the soot, because there is a swift-moving current to carry the soot after it has been dislodged.

Mr. Fette concludes his article with a question that could be answered simply by referring to a textbook on thermodynamics.

Scientists agree that heat is a form of energy and is conceived to be a motion of molecules composing matter, which according to a generally accepted theory are moving or vibrating back and forth with a greater or less velocity. If the movement is slow the body is cold, and if the motion is rapid the body feels warm. A body in motion has kinetic energy, and inasmuch as the molecules composing matter are supposed to be in motion, they possess kinetic energy. Hence we conceive heat to be a form of energy.

Temperature is the term used to indicate how hot or cold a body is. It is not a measure of quantity of heat, but rather a measure of the velocity with which the molecules of a body vibrate to and fro while the quantity of heat may be considered the total energy of the molecules composing the body.

Suppose a vessel is filled with water. For convenience let the vessel be a cylinder. Place the vessel over a fire. Heat is communicated to the molecules of water and the air contained in the water is first driven off and escapes from the surface. The water in contact with that part of the vessel nearest the fire first receives the heat and expands. Its specific gravity is reduced; that is, it becomes lighter than the cooler water above it and it rises to the surface. In this manner the water keeps up a circulation until a temperature of 212 deg. F. is reached. At this stage the molecules nearest the fire attain such a velocity of vibration that they rise through the water, overcome the pressure of the air, and escape in gaseous form, "steam." If the pressure on the surface of the water is increased, it will take more work to force the molecules to the surface and more heat must be applied to make the liquid boil, thus raising what is known as the boiling point. Whenever the pressure is changed, other properties are changed with it. These properties have been determined by direct experiments for all ordinary steam pressures and are found in the "Tables of the Properties of Steam."

Albany, N. Y. ALBERT SMITH.

Obsolete Examination Questions

In the Dec. 23, 1924, issue R. G. Summers invites discussion on the practical aspect of modern examination questions with particular reference to problems relating to the now antiquated lever safety valve. His objection is well taken, but might I suggest that these and similar problems are presented not so much to test a candidate's knowledge of the actual fitting as to determine the extent of his studies on the principles of moments and the laws governing the operation of the simple machines.

In introducing questions of this description, why adhere to similar problems at each subsequent examination? Why not elaborate on the subject slightly and submit problems, say, dealing with the turning moment of the crankshaft, the prony brake, the torsion meter, etc., which are all more or less applications of the same principle. Take for instance, turning-moment problems; in this case the steam pressure on the piston corresponds to the weight on the lever safety valve and the crank takes the place of the lever. The steam pressure tending to open the safety valve is substituted by the resistance set up by the machine driven by the engine. A slight knowledge of trigonometry would be required in order to solve this problem for different parts of the stroke, but then again a slight knowledge of algebra is necessary to solve the lever safety-valve problem, so if one branch of mathematics is involved why not the other.

Returning to the turning-moment problems, I do not mean to infer that it would be advisable to attempt to solve problems of this description from first principles, as proof of the moment of inertia of shafting necessitates the employment of simple integral calculus and this, I understand, is beyond the scope of the examinations.

I quite agree with Mr. Summers that practical questions should be modernized, but of course questions on mechanics, thermodynomics, etc., remain the same throughout the ages. Modernizing the examinations probably means stiffening them up to a certain extent, but I candidly believe that engineers as a body will not object to this course as it will undoubtedly tend to advance the status of their profession.

Detroit, Mich. ROBERT G. MELROSE.

A cloudy coating of powdered graphite applied to the surfaces of handhole and manhole gaskets when being installed, will save time and trouble when they are replaced.

Questions and Answers

Conducted by

Franklin Van Winkle

Overstroking of Duplex Pump

We have a 6x4x6-in. direct duplex steam pump which seems to let loose about two inches from the end of one of the strokes and strikes with considerable force with a recoil of about one inch. The valves are set correctly. How can the trouble be remedied? R. P.

The overstroking with pounding probably is due to loss of cushioning steam from leakage of the piston in its covering of the exhaust port. The remedy would be to provide better piston packing or rebore the steam cylinder and provide tight piston rings. The jumping, or apparent recoil at the beginning of a return stroke, occurs from the presence of air or vapor in the water cylinder, due to running the pump too fast or from attempting to pump hot water under too little head for keeping the pump filled with water.

Setting Safety Valve for Reduced Pressure

In my heating plant I have two 56-in. by 16-ft. return-tubular boilers. The safety valves are set at 125 lb. and it is desired to reduce the pressure to 100 lb. The insurance inspector says that there is no need of changing the springs; just set them. Will they work all right? Could they cause any damage to the boilers? W. A. D.

A safety valve should be of sufficient size and have enough lift to discharge all the steam that could be generated at the safe working pressure for the boiler. The lower the pressure of steam to be discharged the less the density and the larger the valve opening required for discharging the same weight of steam in a given time. Undoubtedly, the inspector has decided that the discharge capacity of the safety valves would be sufficient under the conditions and it is not likely that in following his suggestions any damage would result to the boilers.

Determining Brake Horsepower Delivered by Engine

How can the actual or brake horsepower delivered by an engine be determined? R. M. C.

The friction load of an engine is practically constant for all loads. As the brake horsepower is the net power developed, then for all practical purposes the brake power delivered would be the indicated horsepower when driving the unknown brake load, minus the indicated power when the engine is doing no other work than overcoming its own friction. Another method of determining the brake horsepower delivered for any indicated load is to determine the indicated power developed for various known brake-horsepower loads. Then plotting the indicated power required for various known brake loads, the brake power corresponding to intermediate indicator loads is readily determined.

Submerged Piston and Straightway Pumps

What is the difference between a submerged piston pump and a straightway pump? J. T. H.

Submerged piston pumps are like the ordinary direct duplex steam pumps with both the suction and discharge valves above the water pistons, which are better sealed from being submerged, while in the straightway pattern the suction valves are below and the discharge valves are above the water pistons, so the passage of the water through the pump is more nearly continuous than in the submerged-piston type.

Pitting of Fire Tubes of Heating Boilers

Several of our school buildings that are warmed by vacuum systems of steam heating are equipped with boilers having 3-in. fire tubes. The tubes become pitted through and need to be renewed after two or three heating seasons, whereas the same make and size of tubes used with the same feed water last about five times as long in fire-tube boilers of neighboring factories. Why should there be so much difference in durability of the tubes? P. J. C.

General boiler corrosion of the heating boilers may be more rapid from infiltration of air through leaky supply or air valves or from conditions more favorable to electrolysis induced by stray electric currents. It is also likely that the boilers are not well protected from corrosion during summer seasons. For laying up the boiler the old water should be drawn off. When the boilers are dried they should be closed up tight after placing in them liberal quantities of unslacked lime; or after being washed out, the boilers should be laid up, filled to the top with fresh water containing barely enough lime to make a thin lime wash.

Relative Boiler Output at Different Pressures

Can as much steam be generated by a boiler at 125 lb. as at 100 lb. gage? In other words, will the evaporative capacities at the different pressures be the same, other conditions being equal? T. J. H.

Evaporative capacity is the rate of transfer of heat, commonly referred to the amount of heat required to evaporate a pound of water from and at 212 deg. F., or 970.4 B.t.u. The greater the difference between the temperature of the furnace gases and the temperature of the boiler water, the more rapid the transfer of heat.

Since when steam is generated at 100 lb. gage the temperature of the boiler water is 338 deg. F., and for the generation of steam at 125 lb. gage the temperature of the water would be 353 deg. F., it follows that for the lower pressure there would be a greater difference between the temperature of the furnace gases and the temperature of the boiler water, with rather more rapid transfer of heat and somewhat greater evaporative

capacity at the lower pressure. However, all conditions could not be the same, for to obtain transfer of more heat, the final temperature of the gases would have to be lower. Hence, with this as well as all other conditions except boiler pressure the same, the evaporative capacity would be the same.

For the same evaporative capacity, expressed in heat transferred to the boiler, and the same temperature of feed water there would be fewer pounds of feed water evaporated into steam at the higher than at the lower pressure, since each pound (weight) of steam generated at the pressure of 125 lb. gage would have to contain 1,192.2 B.t.u. and at 100 lb. gage each pound would contain but 1,188.8 B.t.u., or 3.4 B.t.u. less. The relative weight of steam generated for the same evaporative capacity would depend on the temperature of the feed water. With the feed-water temperature 32 deg. F. in each case, the relative weight of steam generated would be inversely as the heat content per pound; that is, as 1,188.8 for steam at 125 lb. gage to 1,192.2 for steam at 100 lb. gage. If in each instance the temperature of the feed water is 150 deg. F., then in the case of generating steam at 125 lb. gage the heat required per pound (weight) of steam generated would be 1,192.2 — (150 — 32) = 1,074.2 B.t.u.; and when generated at 100 lb. gage, the heat required per pound would be 1,188.8 — (150 — 32) = 1,070.8. Hence for the same amount of heat transferred the weight of feed water evaporated into steam at 125 lb. gage pressure would be $\frac{1,070.8}{1,074.2}$, or about 99.7 per cent as much as for 100 lb. gage.

Center of Bourdon Spring Gage

Where is the center of a Bourdon spring gage, by which I mean the hydrostatic center, or the graphic center, or the mathematical center from which we begin to measure pressure on one of these gages when it stands vertical? *C. W. N.*

Bourdon pressure and vacuum gages are supposed to be calibrated to indicate zero for atmospheric pressure exerted in the gage connection at the same level as the axis of the pivot or post which carries the gage pointer or needle. This axis is commonly referred to as the center of the gage. The indications of pressure above atmospheric pressure are assumed to be calibrated to correspond with the hydrostatic pressure that would be exerted by a liquid whose head or height is reckoned upward from the level of the "center of the gage" and, strictly speaking, when the gage tube and conneection are filled with a gas or liquid of the same density as when the gage was calibrated. For all practical purposes the calibration of pressure gages for measurement of pressure above atmospheric pressure are supposed to be true when the gage tube is completely filled with water and the connection filled to the level of the gage center; but for vacuum gages or measurements of pressure below the pressure of the atmosphere the gage tube and connection to the level of the gage center are supposed to be filled only with air or water vapor of the density corresponding with the pressure indicated.

Fig. 1 illustrates a Bourdon pressure gage connected with a liquid column, having the upper end open to the atmosphere. The zero of the dial is supposed to be indicated by the needle when the gage tube is completely filled with water and the connection *n, n, n, D, E* is filled to the level *A B* passing through the center *C*. Indications higher than zero are assumed to be due to pressure in excess of atmospheric pressure such as would be exerted by a liquid column, like *E F* at the level *A B*.

When a Bourdon gage is used for measuring pressures below the pressure of the atmosphere, as when the gage is attached to the suction main of a pump at a point where the pressure is below or at the pressure of the atmosphere, the reading is assumed to be true for the elevation where the gage is connected to the suction pipe, and the gage tube and connection are assumed to be filled with air at the pressure below atmosphere indicated by the gage. To assure accuracy of readings, a pet cock should be attached to the gage pipe below the gage cock and opened occasionally to free the gage and pipe of air in the case of measuring pressure above the pressure of the atmosphere, and for

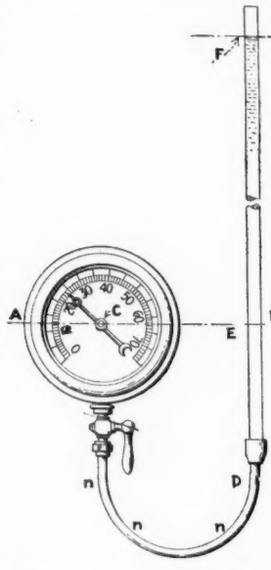


Fig. 1 — Hydrostatic pressure referred to gage center

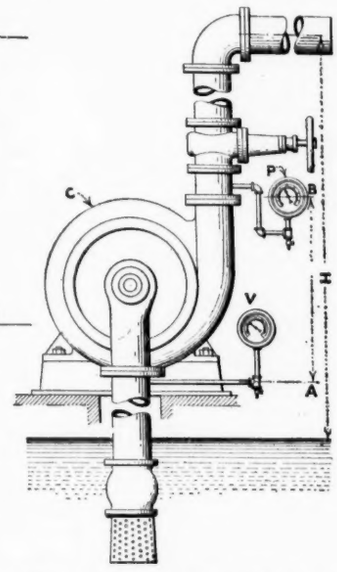


Fig. 2—Suction lift referred to vacuum gage connection

freeing the gage and connection of water in case the gage is used to indicate pressure below the pressure of the atmosphere.

Referring to Fig. 2, the total head *H* to be credited to a pump *C* would be found by adding together the head corresponding to the pressure shown by the gage *P* on the force main, the lift corresponding to the vacuum shown by the vacuum gage *V* and the vertical distance *A B* in feet between the center of the force main gage *P* and the point where the suction gage pipe connects with the suction main. However, if the suction main were under pressure instead of a vacuum, the suction gage should be attached at such a level that the connecting pipe and gage tube may be filled with water when the pet cock is opened. In that case the correction for difference in elevation of gages which is the vertical distance between the centers of the gages is to be added to the reading of the force main gage and from that sum the pressure reading of the suction gage is to be subtracted.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Does Size Affect Coal Weight?

DO LARGE sizes of coal weigh more than small or vice versa? This is not merely an interesting subject for speculation and experiment. It is a matter of practical every-day importance to engineers.

Lumps of coal might be idealized into balls or spheres. A study of the effect of the size of balls upon the weight of a cubic foot of them should shed some light on the corresponding problem for coal.

Fig. 1 shows a ball that just fills a hollow cube. The volume of the ball will be 52.4 per cent of the volume of the cube regardless of the actual dimenions. The weight of the ball (if solid) will be 52.4 per cent of the weight of a solid cube of the same thickness and material.

When it comes to stacking a lot of balls in a box the volume occupied depends on the method of stacking. If stacked "square" in all three dimensions (Fig. 3) the volume of the balls will still be 52.4 per cent of the volume of the box just as in Fig. 1.

Staggering the balls brings them closer together and increases the number and net volume that can be gotten into a box of given capacity. Take a single layer staggered as shown in Fig. 2. The distance between center lines will be reduced to 86.6 per cent of that with square packing, so only 86.6 per cent as much "floor area" will be taken up by the same number of balls.

When the layers also are staggered, as shown in Fig. 4, the vertical distance from the center of one layer to the center of the next will be but 81.6 per cent of that for square packing. Hence the total volume occupied by a given number of balls will be $0.866 \times 0.816 = 0.708$, or 70.8 per cent of that occupied with square packing. With square packing the net volume was 52.4 per cent of the volume of the box. Therefore with staggered packing as shown the net volume will be $52.4 \div 0.708 = 74$ per cent of the volume of the box.

If coal came in perfect spheres of constant size nested perfectly as shown in Fig. 4, the weight per cubic foot would always be 74 per cent of the weight of a solid one-foot cube of the same coal regardless of the size. Even if the lumps were of irregular shape, some other constant ratio would always hold regardless of size if the lumps were always uniform and of the same shape.

The truth of this statement is made clear by a study of Fig. 5, which shows a box holding one cubic foot of coal crushed to a rather small size. The whole cubic foot is assumed to weigh exactly fifty-six pounds, which is about right for certain grades of anthracite coal. In a corner of the box a smaller cube, 6 in. on a side, has been indicated by dotted lines. Evidently, this cube will have a volume of one-eighth cubic foot. The coal it contains will weigh one-eighth of the total, or 7 pounds.

Now imagine this small cube enlarged photographically up to the size

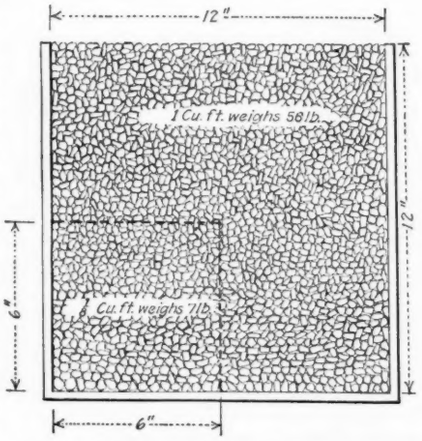


Fig. 5—If small cube (dotted) were "photographed" up to 1 ft., weight would be 56 lb. per cubic foot with dimensions of lumps doubled

of the original 1-ft. cube of coal. Each lump will appear exactly as it does now in the small cube, but each dimension will be doubled. It is a well-known law of geometry that the volume and weight of a solid object of any given shape and material is proportional to the cube of any dimension. If all the dimensions are doubled each lump will weigh eight times as much as before and the new cubic foot will weigh $8 \times 7 = 56$ lb. as before, although the lumps are much larger.

TABLE I—VARIATION OF WEIGHT OF ANTHRACITE WITH TRADE SIZE

	Weight Per Cubic Foot, Lb.	
	Schuylkill Region	Lykens Region
Egg	56.8	51.6
Stove	55.5	51.0
Nut	54.6	50.0
Pea	53.8	49.5
No. 1 Buckwheat	53.0	49.0
No. 2 Buckwheat	52.0	48.6
No. 3 Buckwheat	51.0	....

TABLE II—AVERAGE WEIGHT OF AMERICAN COALS

Coal	Wgt. of 1 Cu. Ft. Solid, Lb.	Wgt. of 1 Cu. Ft., Broken, Lb.	Per Cent Solid
1. Anthracite	93.78	53.05	56.5
2. Bituminous, free-burning	84.93	52.84	62.3
3. Bituminous, coking	83.90	49.28	58.7
Average of 1, 2 and 3	87.54	51.72	59.0
Cokes	....	32.13	....

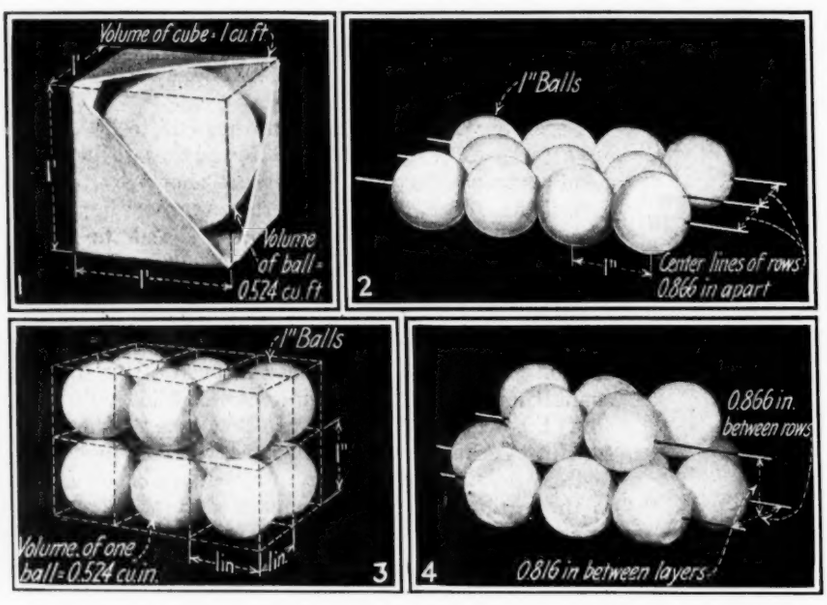


Fig. 1—The ball fills 52.4 per cent of the total volume. Fig. 2—Center distances of staggered rows are 86.6 per cent of ball diameter. Fig. 3—With square-packed balls the net volume is 52.4 per cent of the total. Fig. 4—Center distances of staggered layers are 81.6 per cent of ball diameter.

New and Improved Equipment

Furnace Fire Observer

A convenient and practical device designed to give a clear view of the furnace, without injury to the eyes or exposure to the heat and without admission of cold air into the furnace, has been developed by the Vastine Engineering Products Co., 549 West Washington Blvd., Chicago. It consists of a hollow metal enclosure with reducing cross-section, set in the furnace side wall. Winding passages in the frame through which air is circulated, keep down the temperature and in addition thin ribs or fins on the exterior help to dissipate the heat.

Fig. 1—Observer installation with single glass door

In the observation end are fitted four rectangular pieces of plate glass, to provide for expansion, each 5x6 in. and ¼ in. thick, and blue or chartreuse in color. Within the observer, near the glass, is a grid of 1⅛-in. spacing, and at the inner end is a second grid with ¼-in. spacing. Their purpose is to segregate and bring out in greater detail the various sections of the fuel bed, as well as the true color of the flame and incidentally shade off much of the radiant heat.

The observer frame and door, in which the four pieces of glass are mounted, afford a clear view of fully three-fourths of the furnace. The observer frame extends about halfway through the boiler wall, and from this point inward the opening in the brickwork is flared to conform to the angles of the observer walls. At the outer, or observation end, the glass measures 6x18 in., while the inner end is only 4½x6 in. Thus four times as much area is exposed to cool air as to the heat of the furnace, and at the same time the maximum angle of vision is just as great as though the taper had been reversed. Where conditions will not permit installation of the observer in the brickwork, smaller designs are available for attachment to furnace or inspection doors.

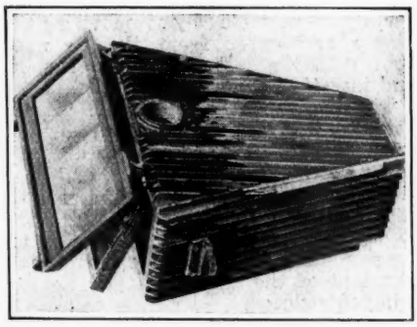


Fig. 2—Observer for high temperatures with double glass doors

With furnace temperatures of 2,600 to 2,700 deg. the temperature of the glass ranges from 120 to 160 deg. For extremely high temperatures a double glass with air circulation between the panes is used. With furnace temperatures exceeding 2,700 deg. the temperature of the glass does not exceed 120 deg.

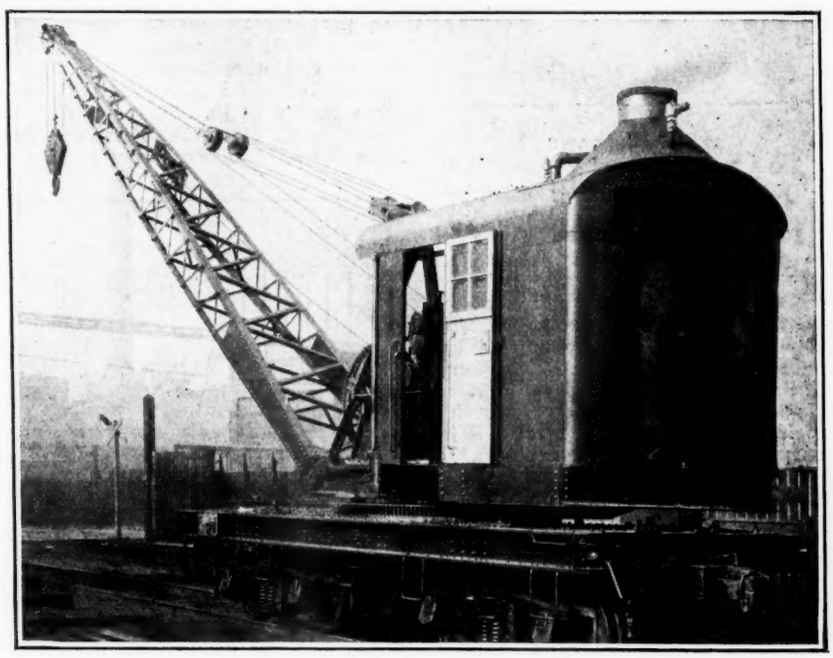
A small quantity of air from the boiler room is drawn through the cooling channels of the observer frame by the suction within the furnace. In the case of forced draft, where the furnace pressure may be positive, a small connection is made to the windbox of the stoker and the cooling air blown through the observer channels into the furnace. The cooling tends to preserve the casting so that it should last indefinitely. In a trial installation no difficulties have been experienced with the glass.

Brownhoist Improved Locomotive Crane

The Brown Hoisting Machinery Co., of Cleveland, Ohio, has just brought out an improved model of its 20-ton locomotive crane. The changes include a high boom hitch, wide truck frame, extra-large diameter rotating ring and improved contour of the cab.

The crab has been simplified by the elimination of one shaft, thereby making the remaining parts much more accessible. The drums are independently driven and free running with outside band clutches. The worm-gear boom hoist runs in an oil bath, and this, with the high boom hitch, makes booming with loads an easier operation.

The wide truck frame permits an extra-large rotating ring, which adds to the stability of the crane. The load



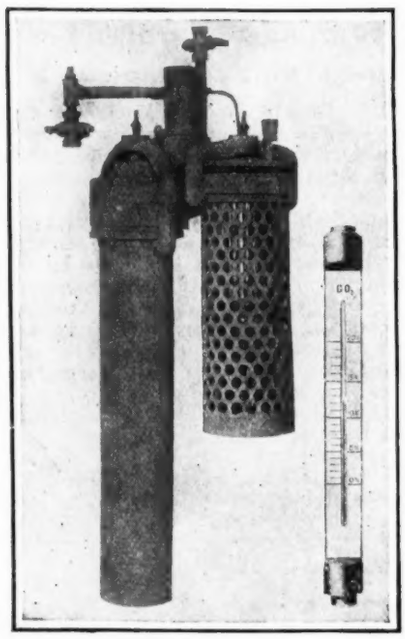
Improved locomotive crane of twenty tons capacity

rollers that support the revolving superstructure are larger and are removed from above without jacking up the superstructure. The vertical shaft can also be removed from above.

The cumbersome counterweight device for retrieving the tag line and electric cable in grab bucket and magnet work has been discarded, and in its place an arrangement that is both compact and novel has been installed. The main hoist shaft is extended through the crab far enough to accommodate a small drum and "niggerhead," the latter being keyed to the shaft. The small drum, upon which the tag line or electric cable is wound, is rotatably mounted on the shaft and is driven by the niggerhead through a slip friction device.

The "APEX" CO_2 Indicator

A type of CO_2 instrument, developed primarily to meet the demand from the smaller steam power and heating plants for a comparatively simple and inexpensive instrument has been



APEX indicator

brought out by the Uehling Instrument Co., Paterson, N. J.

The instrument consists of two principal parts, the actuating device, or CO_2 meter, and the gage, or indicator. The flue gas flows through the CO_2 meter continuously, developing a changing pneumatic pressure within it, the magnitude of the changes depending on the percentage of CO_2 present in the gas. The CO_2 is absorbed in a dry cartridge placed in the meter. The absorption of CO_2 causes a shrinkage of the gas flowing through the meter and hence a reduction in the pneumatic pressure. The indicator shown at the right of the figure consists simply of a manometer containing a glass tube filled with colored liquid, which changes its level according to the pneumatic pressure applied to it. A scale beside the indicating manometer is graduated in percentages of CO_2.

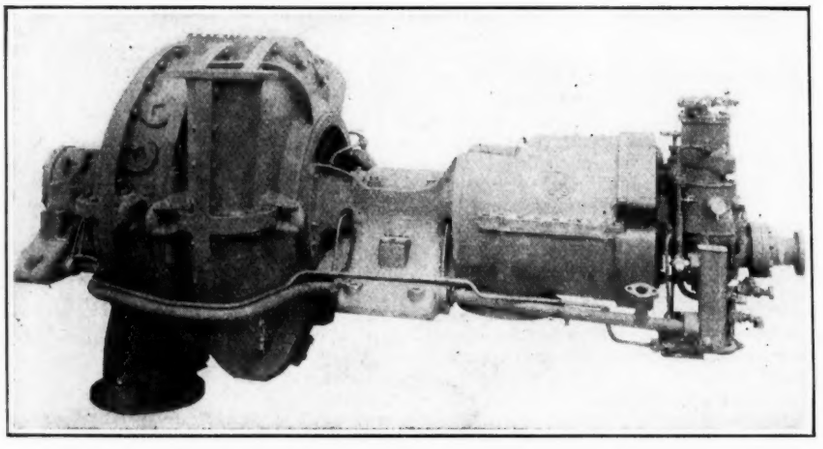
A simple steam or water aspirator is used to draw the gas from the boiler, through the meter, a large quantity of gas being bypassed around the meter at the same time. The suction from the aspirator is maintained constant by a simple hydrostatic regulator consisting of a closed vessel filled with water, the space above which is connected with the aspirator. An air inlet pipe extends into the water to a point near the bottom of the vessel and is so arranged that air may be drawn in through the bottom of this pipe and caused to bubble up through the water under the effect of the suction above the water. This bubbling air automatically prevents the suction from increasing beyond the point for which the regulator is designed. The water level in the regulator is kept constant by a fixed overflow. The absorbent cartridges used with the instrument are each guaranteed for a life of 1,200 per cent hours and are readily renewable by removing the clamp and cover from the chamber shown at the left of the instrument and inserting a new cartridge.

The instrument employs the "Pyroporus" filter, which is placed on the end of the sampling line within the boiler setting to exclude soot and ash. A secondary filter removes the sulphuric acid fog from the gas and tends to dry it, thus preventing corrosion of the sampling line. A corresponding instrument of the recording type is also being introduced.

General Electric Multi-Stage Centrifugal Compressor

The General Electric Co., Schenectady, N. Y., has recently developed a line of multi-stage centrifugal compressors designed to deliver volumes of 3,000 to 60,000 cu.ft. of air per minute at pressures up to 30 lb. and above. The compressors have been developed for furnishing various volumes at higher pressures than ordinarily obtained with single-stage machines and are particularly adapted for use in blowing blast furnaces, Bessemer converters and other services where large volumes of air are required at pressures up to 30 lb. The line also includes small machines with capacities from 250 to 1,400 cu.ft. per minute at pressures of from 2 to 6 lb. All types are either motor or turbine driven.

Simpler and stronger construction and higher efficiencies are some of the advantages claimed for the new compressors. The conversion passages have also been improved and the interstage passages simplified. Each complete unit has four bearings and an automatically lubricated coupling. In addition to these changes the governing devices for these machines including the constant volume, constant suction and constant pressure governors, have been improved.

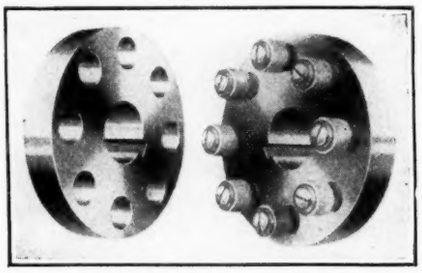


Multi-stage turbine-driven centrifugal compressor of 8,500 cu.ft. capacity

Terry Flexible Coupling

The illustration shows a coupling of the usual pin and bushing type now being put out by the Terry Turbine Co., Hartford, Conn.

The halves of the coupling are made from special composition steel forgings and are machined all over and balanced after machining to avoid the possibility



Flexible coupling of pin and bushing type

of vibration being set up in the coupling. The pins are fitted with rubber bushings fastened to flanged steel spools to protect the ends of the bushings from wear. The rubber bushings are ground to exact diameter after mounting to insure equal distribution of load. The couplings are available in capacities up to 400 hp. per 100 revolutions per minute.

Erratum—The steam trap illustrated on page 822, Nov. 18, 1924, issue was incorrectly named "Pryko." This trap was developed and is manufactured by William Wanstall and is being marketed through Pryko, Inc., 39 Cortlandt St., New York City.

Identification Markings for Piping Systems*

The Subcommittee on Identification Markings Other Than Color submits the conclusions which were arrived at from field investigations and personal interviews with operators and designers of power and industrial plants and also from articles appearing in the technical press.

An attempt was also made to discover the methods of pipe-line identification employed in the foreign field. It was found that practically no attention has been given to the question of pipe markings, and where paint is employed its application is intended as a protection for the pipe covering material rather than as a means of determining the nature of the fluid flowing through the lines.

Symbols Objectionable

It was first thought that the work of the committee should supplement the report of the Subcommittee on Identification by Color, but as the subject matter of this report will indicate, it apparently becomes a separate phase of the subject. They have, however, made certain suggestions pertaining to color with reference to the proposed markings.

The first efforts of the committee centered upon a combination of symbols or hieroglyphics along with a legend naming the nature of the containing fluid. They have since discarded the symbol idea entirely and now consider it impracticable because of the great mass of detail involved, the difficulty an operating force would encounter in recalling to mind the different shapes and forms and the probable necessity for the publishing of a code book upon the part of each operating company.

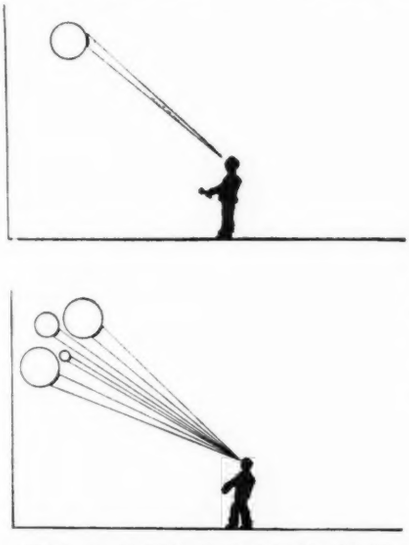


Fig. 1—Overhead pipes should be marked on lower sides for better visibility, and less dust

It is recommended that the form of identification marking shall consist principally of a lettered legend, abbreviated or otherwise, naming the material carried in the pipe line. Where a knowledge of the direction of fluid flow may be of service, it is suggested that arrows be painted on the pipe.

Lettering Overhead Pipes

Attention has been given to the question of visibility with reference to pipe markings. Where pipe lines are located some distance above the normal line of the operator's vision the lettering should be placed below the horizontal center line of the pipe as in Fig. 1, which shows a group of pipe located near a wall. It is desirable, where the view is unobstructed, that the lettering employed be stenciled on the two lower quarters of the pipe covering rather than one side only. The lettering in the position shown will be less liable to be obscured by dust collection or mechanical damage.

SIZES OF STENCILS FOR PIPE COVERINGS OF VARIOUS DIAMETERS

Outside Dia. of Pipe or Covering, Inches	Size of Stencil Letter, Inches	Outside Dia. of Pipe or Covering, Inches	Size of Stencil Letter, Inches
¾	½	5	1½
1	½	6	1½
1¼	½	7	2
1½	½	8	2½
2	¾	9	2½
2½	¾	10	3
3	¾	11	3
3½	1¼	12	3½
4	1¼	13 and over	3½
4½	1½		

In certain types of plants it may be desirable to label the pipes at junction points or points of distribution only, as suggested in Fig. 2. In certain existing power plants the markings are repeated at intervals all along the pipe line. In any case the operating man should decide the location and number of signs required in each particular system of piping.

The Use of Stencils

Stencils of standard sizes are easily obtained from any stencil manufacturer, ranging in height from ½ in to 3½ in. For pipes smaller than ¾ in. in diameter requiring identifying marks the use of a metal tag with the lettering etched and filled in with enamel, is suggested. A tabulation of suggested heights of letters for different outside diameters of pipes or pipe coverings, is included.

Vehicles have been developed which, with aluminum powder, make a paint that will stand up under temperatures from 700 to 900 deg. F., without loss in color or adherence. Black letters for dark coverings may be either painted or stenciled on a rectangular background of aluminum about as indicated in Fig. 2. The "Median Gray" referred to in paragraph 4, page 3, of the Paint Committee's report, an abstract of which appeared in the Jan. 15, 1924, issue, might be used if found suitable for the service.

The Committee on Plan and Scope has already reported in favor of the use of aluminum paint on lines carrying extra valuable materials, but this fact need not exclude its use as a background for the proposed lettering.

The system of marking here suggested is believed to be the most practicable form, everything considered, and its adoption is recommended by the subcommittee, who are: Willis Lawrence, J. J. Howe, R. C. Taggert, T. M. Gevrenz, and W. S. Morrison, chairman.

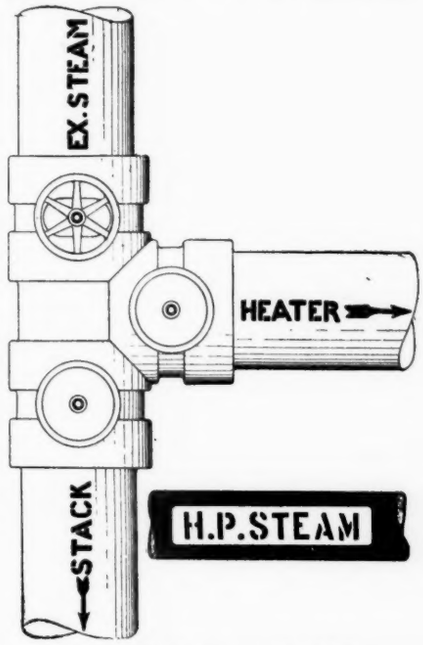


Fig. 2—Black letters should have light backgrounds

It is probably correct to say that the present attitude of the engineers and executives of this country with respect to low-temperature distillation as an adjunct to power production from fuel is hopeful but not overly enthusiastic. The promises made are very enticing, and the modicum of success already achieved is encouraging, but there is as yet no real evidence of successful commercialization. One point in this connection seems to deserve special mention. Any wide-spread use of such processes would bring into the market tar oils and other byproducts in quantities not yet dreamed of, and it is only reasonable to suppose that the result would be a marked drop in prices. Therefore, it would seem that any calculations made for the purpose of proving the wide-spread applicability of such processes must assume selling prices for byproducts materially lower than those now prevalent. Most calculations made to date seem gracefully to ignore such a possibility.—*C. F. Hirshfeld.*

Kentucky River Project—The Kentucky Hydroelectric Co. has applied for a preliminary permit covering a project on the south fork of the Kentucky River. It is proposed to erect a dam 160 ft. high, one mile above Booneville.

* The Committee on Code for Identification of Piping Systems is a sectional committee organized under the rules of the American engineering standards committee by the joint sponsors: The American Society of Mechanical Engineers and the National Safety Council. This is abstracted from their report of Oct. 10, 1924.

Tendencies in Steam Turbine Practice Abroad*

By Francis Hodgkinson†

IT SEEMS that turbine practice in Europe is in a transitory stage, and the changes are well worthy of study at our hands. They are reaching out for higher efficiencies, and one must consider in the doing of it to what degree reliability may be imperilled and to what degree we on this side may profit thereby. Are their standards of reliability lower than ours? It is impossible to answer that question, but it appears that more spare units are carried there than here and that utility companies do not expect the manufacturer to carry an insurance policy for them in this regard.

Some few years ago there were reports of high efficiencies at least as being guaranteed with high velocity, high pressure elements, resulting in turbines of large capacities at given speeds with few stages, sometimes as low as eight single-row stages. These were in some cases entirely of impulse type, and in others, combinations of impulse and reaction types.

In spite of some recorded tests to the contrary, results with this type of machine have been disappointing, and from the Beama (British Elec. and Allied Manufacturers Assn.) tests on nozzles, has come the realization, long felt by at least some engineers in this country, that the best economy is to be secured with high-pressure elements running at low speeds. This is obviously so for reasons other than the somewhat abstruse ones disclosed by the Beama tests, because with a given steam flow larger nozzle and blade passages may be employed, thus involving lesser leakage ratios and lower disk friction. All these things are conducive to higher efficiency.

The development of the thought, of a turbine of many stages in the high-pressure zone has led many European designers to turbines of the tandem-compound principle, at least for their machines of maximum capacity at given speeds, in order to secure greater mechanical rigidity of the small shaft and many stages of the high-pressure portion, and to maintain fine clearances.

A good deal has been heard lately about the activities of the "Erste Brünner Maschinen-Fabrik Gesellschaft" and their exploitation of machines of a design based on the thought of high-pressure elements operated at low velocity. Remarkable results were secured with a 2,300-kw. non-condensing machine adapted for service where exhaust steam at some pressure above atmospheric was needed for some industrial process. Authentic tests by Dr. Stodola showed an over-all efficiency of turbine alone of 82.4 per cent.

It is obvious that such a turbine compounded with low-pressure elements would be a step in advance for a complete condensing power house unit. This general idea was subscribed to many years ago by at least some in this country, and hardly constitutes novelty. Nevertheless, Erste Brünner has secured a number of licensees, particularly in Germany, and at least one in Holland.

These licensees are offering machines of this type, in fact, going apparently to an extreme in the matter of tandem-compounded cylinders. In one case a 50,000-kw. machine is being offered in four tandem cylinders, one high-pressure, one intermediate, and two single-flow low-pressure elements to operate at 1,500 r.p.m., 357 lb. sq.in., 660 deg. F. total temperature, and 29 in. vacuum. A steam consumption of 8.11 lb. per kw.-hr. is expected.

Another licensee, the Gebrüder-Stork Co., of Holland, is building a unit, which was described at the World Power Conference, of 16,000 kw., to operate with 456 lb. pressure, 750 deg. F. temperature, 69 deg. F. temperature of cooling water, on which 8.44 lb. per kw.-hr. has been guaranteed, which corresponds to an over-all efficiency of 86 per cent for the turbine alone.

Without doubt designers have been led to this extreme multiplicity of cylinders for the reasons previously stated, as well as for the sake of increased reliability, securing rigidity with small diameter shaft, and to enable them to operate with the interstage labyrinths at minimum clearance. It has been reported, but not authoritatively, that axial clearances in these turbines between blades and nozzles approximate 0.005 inch.

Fine clearances at this point are of course conducive to efficiency. It must not be lost sight of that there are losses incidental to taking out steam from one cylinder by means of a pipe and admitting it to another. Notwithstanding this, however, excellent results will no doubt be secured with machines built on these lines and a number of manufacturers, licensees and otherwise, are subscribing to this principle and their later important machines are being arranged as tandem-compound machines. The General Electric Co., in this country, has built a few multi-stage low-velocity machines which I understand have given excellent results.

The Westinghouse company has advocated the cross-compounding of large turbines, for two particular reasons: In the first place, by operating the low-pressure element at relatively low speed, any desired last-row blade area can be employed, and hence, any degree of low terminal loss secured. Simple blade constructions involving any degree of low stress desired may be employed. The high-pressure element of course will operate at a higher synchronous speed selected to give the highest efficiency with the steam volumes involved.

The second reason to all the foregoing is that there is added a real modicum of reliability by virtue of the greater simplicity and the lesser size of the two independent structures, the lesser temperature range and heat drops to be reckoned with. This thought was exploited by this company as far back as 1914, when two-speed cross-compounds were first built. This has been lately subscribed to with a further improvement of this idea, by Sir Charles Parsons in the case of the 50,000-kw. turbine being erected in the Crawford Avenue plant of the Commonwealth Edison Co., where the last expansion from about 26 in. vacuum down is carried out in a low speed element arranged tandem fashion with, but not coupled to, a higher pressure element.

*Abstract of paper presented at the Metropolitan Section, A.S.M.E., Oct. 15, 1924.

†Chief Engineer, South Philadelphia Works, Westinghouse Electric & Manufacturing Co.

Defective Electric Power Appliances

By A. L. H. Street

The responsibility of an electric power company for personal injuries resulting from defective instrumentalities used in supplying current to an industrial plant was recently considered by the Oklahoma Supreme Court in the case of Hoover vs. Minnesota Electric Light & Power Co. (229 Pacific Reporter 285).

The plaintiff, an employee of an oil refining company, was injured through contact with defectively insulated wires leading from the defendant's high-voltage electric line to the refining company's plant. The substance of the decision handed down follows:

Where an electric power company furnishes current to a consumer through wires and appliances constructed and owned by the consumer, there is no duty on the part of the power company to continue inspections to see that the wires and appliances are maintained in safe condition. Quoting from a legal authority which summarizes the law as laid down by courts throughout the country, the opinion reads, in part:

"The duty and responsibility of a mere generating company is limited to making a proper connection and delivering the electric current to the purchaser's wires and appliances in a manner which, so far as such delivery is concerned, protects life and property, and there is no duty of inspection to see that the purchaser's wires and appliances are in a safe condition and kept so. While the weight of authority supports the foregoing rules, there are cases holding that it is the duty of a mere generator of electricity to see that the wires and appliances of the customer are in proper condition safely to receive it, and that such duty extends to all wiring and apparatus upon streets, highways and places where persons may be expected to be although not the property of the supplier of the current, except that no such duty is owed to patrons who own and control electrical fixtures upon their own private property, a distinction being drawn between injuries to third persons as to whom there is a duty to exercise care, and injuries to a consumer who owns and controls the defective wires and appliances as to whom no duty of inspection exists." (20 Corpus Juris, 364.)

Governor Smith Reiterates Arguments for Public Ownership and Operation of Utilities

Message to Legislature Contains His Policy on Water Power, Superpower and Public Utilities

GOVERNOR ALFRED E. SMITH, in his annual message to the Legislature of New York State, reiterates the administration's policy in relation to water power and public utility regulation. On these subjects he has to say:

"I can think of nothing in this state of so much importance to the people as the immediate development of the state's great water-power resources and their transmission in hydro-electric power. Millions of tons of coal are hauled into this state annually to provide light, heat and power, and countless millions of cubic feet of water capable of generating this power are running to waste. They should be developed in the interest of the people at the earliest possible moment, but the vital question is one of fundamental policy. The State of New York and the various municipalities have received severe lessons in what it means to alienate natural resources and permit them to fall into private hands for private development and private profit.

"In my first message to the Legislature of 1924, I advocated a plan which met the chief obstacle to every proposal for state development advocated in the past. Objections had heretofore always been based upon the enormous cost of development and the contemplated use of state money or state credit and the issuance of state bonds. My suggestion provided for the establishment of a New York State Power Authority to be a public corporation, municipal in character, having no stockholders, deriving its powers from the state and having the duty specifically imposed upon it to take over and develop the water-power resources that are now the property of the state. I dealt in detail with what, in my opinion, are the fundamentals of such a plan and I refer you again to that message."

Superpower

"We hear much talk about superpower proposals. That means a power development breaking down state lines and state control and developing power on a regional basis. It is readily seen that power turned over to private companies under such circumstances creates a monopoly more powerful and more sinister than any which we have heretofore known. In the distribution of hydro-electric power homes and farms, as well as industries and municipalities, must be considered, and no plan for development should be permitted to throttle or expand any given section or any given community on the sole basis of private profit. Development and transmission must be placed on the basis of the common good."

Public Utilities

"In my last annual message I recommended that the present Public Service Law be amended so as to return to the localities of the state the power they had held over their own public-utilities contracts until the enactment of legislation in 1921, which transferred the jurisdiction and power from the localities to a state commission. I have yet to hear any fair and reasonable defense to that invasion of home rule. At the time that it occurred and ever since, it has met with opposition in every large municipality of the state. This power should be returned to the municipalities, and they should have a free hand to deal for themselves with the corporations with which they made contracts at any time in the past. As a matter of fact, instead of a policy of centralization, we should broaden the state's policy and delegate to municipalities where they so desire, the agency of the state for the regulation of all public-utility corporations within their borders.

"There is nothing new or revolutionary about the theory of municipal ownership. New York City now owns railroads and owns and operates ferry boats. Several cities of the State—Jamestown, Dunkirk, Long Beach and Salamanca—own and operate their electrical plants. Fifty-six villages either generate their own electricity or, even if they arrange to buy current, own the distributing system, and three villages own and operate gas plants. In fact, one of these has just announced a 10 per cent reduction of rates for electricity furnished by the town plant. I simply recommend that the principle now in practice in New York City and other places in this state be extended to all forms of utilities and be made applicable to all cities."

An unexpected development at Albany was the declaration of the Republican legislative leaders there for a renewal of the contest with the United States government over the rights of the state as affected by the Federal Water-Power Act. A water-power plank is contained in an official program put forward by the Republicans, who control both houses of the Legislature by large majorities.

Susquehanna River Project To Cost $52,000,000

Because of the desire of the Susquehanna Power Co., of Bel Air, Md., to proceed as rapidly as possible with its project on the Susquehanna River, a meeting of the Federal Power Commission was held shortly after the first of the year to pass on the company's application for license.

The project contemplates the erection of a dam with a crest elevation of 103 ft. above the sea level, which will create slack water for a distance of ten miles to the tailrace of the existing Holtwood plant. The power is to be sold to the Philadelphia Electric Co.

The conditions under which this license was authorized mark the first instance where the Federal Power Commission has assumed authority over the regulation of financing, rates and services. This is done because the power is to be developed in Maryland and sold in Pennsylvania. Under these conditions it would not be subject to regulation by either state. The State of Pennsylvania in effect insisted that the Federal Power Commission assume jurisdiction.

This project is comparable with the development at Muscle Shoals. With the initial installation it is proposed to produce 1,233,000,000 kw.-hr. When the ten units, for which provision is being made, are installed, the output will be 1,560,000,000 kw.-hr. It is expected that this will displace no less than 700,000 tons of coal annually in the Philadelphia area.

The cost of the project is estimated at $52,200,000.

The dam is opposite the town of Darlington, 4½ miles above the head of navigation in the tidal portion of the river near the head of Chesapeake Bay. The initial installation will include six main generators which will develop 280,000 hp. When the four additional units are installed the initial capacity will be raised to nearly 500,000 hp.

The intake is to be at the west end of the dam. The high-tension station will be built on that side. Two 220,000-volt transmission lines are to be built at first, but the right-of-way is being provided for a third circuit to be installed later.

Owing to the cost of relocating the Columbia-Port Deposit Railroad on the east bank of the Susquehanna, it is not regarded at this time as being economically feasible to develop the full head in the initial installation.

Bureau of Coal Economics Sponsored By Oddie

An amendment to the Department of Mines bill was introduced by Senator Oddie on Jan. 8 which advocates the establishment of a Bureau of Coal Economics as a part of the Department of Mines. The duties of the Bureau are described: "It shall be the duty of the said Bureau to publish currently, . . . studies and reports covering all essential facts respecting production, transportation, distribution, marketing, storage, prices, costs, wages, rates, employment, earnings of miners, living conditions, and cost of living in mining communities, ownership of and title to coal mines and coal lands, organizations and persons connected with the coal industry, profits of mine operators, profits of other individuals, partnerships, corporations or associations having to do with the production, distribution or sale of coal, waste of coal, wage contracts, irregular production, general conditions under which coal is produced, the causes of strikes in the coal industry, and all other facts necessary to the development of a wise public policy touching the coal industry."

Start Research on Metals at Extreme Temperatures

A joint research committee representing the American Society for Testing Materials and the A.S.M.E. have been selected for a "Research on Properties of Metals at Extreme Temperatures." The personnel selected is: George W. Saathoff, chairman, Henry L. Doherty & Co.; George K. Elliott, Lunkenheimer Co.; H. J. French, Bureau of Standards; Vincent T. Malcolm, Chapman Valve Co.; John A. Matthews, Crucible Steel Co.; LaVergne W. Spring, Crane Co.

In the report of the Joint Symposium Committee, which held a session at the Spring meeting of the A.S.M.E. at Cleveland last year, the three objects to be accomplished by this Research Committee were outlined as follows:

"Accumulation of existing unpublished data covering satisfactory and unsatisfactory service in different fields of engineering of various metals under extreme temperatures.

"The making of studies leading to standardization of the procedure for testing materials at high and low temperatures. These should preferably include studies of new comparative tests of metals by the principal methods now in use in various laboratories and likewise a critical examination of data already published.

"Outlining and fostering new research work in this field. The first and most important materials to be investigated are considered to be carbon and alloy steels, so-called 'heat-resisting' alloys consisting of various combinations of nickel, chromium, iron, tungsten, molybdenum, etc., and trimming materials (chiefly alloys of nickel and copper) for valves and equipment intended for high-temperature service in power stations, oil refineries, etc."

While certain of the members of the committee may personally conduct investigations along the lines indicated, the principal functions of the committee will be to serve as a clearing house for information and as a stimulus to those who are making original investigations in this field.

Oil Conservation Conference To Be Called

The Federal Oil Conservation Board, created recently by President Coolidge, announced on Jan. 7 that invitations would be sent out soon for a meeting in February of representatives of the private oil interests with the Board and its government experts in an attempt to formulate a conservation plan which will benefit the industry and the country, according to press reports.

The Board, which is composed of Secretaries Weeks, Wilbur, Work and Hoover, met on Jan. 7 and made Secretary Work chairman. They also designated representatives of their departments as a subcommittee to study the technical side, including present production methods and the fundamental importance of a national conservation policy. The subcommittee includes: Dr. George Otis Smith; Brig. Gen. Edgar Jadwin; Rear Admiral H. H. Rousseau and Guy H. Riddell.

Secretary Work pointed out that government experts have estimated that 30 per cent of the oil every year comes from new fields, and generally half of the total from any field is produced within the first two years, which would seem to imply that "if oil companies should fail over a period of two years to find, at home or abroad, new production to offset our depletion, an oil famine would result."

The United States produced 70 per cent of the world's consumption of oil, and an oil famine, the Secretary added, would paralyze the nation's industries.

Secretary Work further remarked that protection of the oil business as well as the Government is sought and that the problems of overproduction, excessive costs and waste are to be studied.

Underwood Muscle Shoals Bill Wins in First Vote

LATE on the afternoon of Jan. 8 the Senate voted, 48 to 37, to substitute the Underwood leasing plan for the Norris government operation bill of Muscle Shoals.

The Underwood measure provides that President Coolidge would have until Sept. 1 to lease the property and, in the event that a favorable lease should not be obtained, to work out a scheme of federal operation.

In the bill as drafted by Senator Underwood, the Secretary of War was charged with the duty of leasing the property. Senator Underwood consented to an amendment that gave the authority to the President.

It was settled by unanimous agreement under the provisions of which amendments to the measure can be proposed before the final roll call on passage is ordered. Several amendments are pending, including one by Senator Wadsworth which proposes that a commission, with the Secretary of War as chairman, make a survey of the Muscle Shoals project and recommend the most advantage system for its management and further development. The Norris bill will be voted on again before the final vote on the Underwood bill is reached, it is stated.

Bureau of Mines Wants Fuel Engineers

The United States Civil Service Commission announces an open competitive, non-assembled examination, for fuel engineer, associate fuel engineer and assistant fuel engineer. The vacancies exist in the Bureau of Mines. Applications must be submitted by Feb. 3. Entrance salaries will be $3,800, $3,000 and $2,400 a year respectively, with advancement in pay up to $5,000, $3,600 and $3,000. Appointees must be able to conduct laboratory and field fuel investigation, especially in combustion, furnace design, smoke prevention, heat transmission and efficiency of fuel-using devices, and must also be able to prepare concise and intelligent reports thereon, etc. Information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or at the post office or custom house in any city.

Rittman Advocates Getting Oil Out of Coal First

Making the Nation's annual coal consumption of 800,000,000 tons yield 8,000,000,000 gallons of petroleum oil which could be converted into gasoline for automobiles; using the byproducts of the process for producing power, with resultant cheaper power at large central generating stations, is a proposition advanced by Dr. W. F. Rittman, formerly of the United States Bureau of Mines. Doctor Rittman, now of Carnegie Institute of Technology, addressed a "giant power" conference at the annual convention of the American Economic Association in Chicago recently. According to press reports he said:

"The use of oil under boilers for power is a criminal waste of a limited natural resource. All oil should be manufactured into gasoline for the automobile, a process now possible of accomplishment.

"Instead of using oil to replace coal for power, coal should be made to yield its byproduct, oil, which in turn can be made into gasoline. When properly byproducted by distillation, coal can be made to yield more than 10 gallons of oil per ton, and the solid residue used to make power.

"Byproduct plants should be an integral part of all central power plants, thereby assuring a gasoline supply for automobiles, eliminating smoke and making a cheaper electrical power."

The 8,000,000,000 gallons of oil which Dr. Rittman would recover from coal is approximately one-third of the nation's total production of petroleum for the year 1922.

New Employment Bulletin for Engineers

The employment service conducted by the Four National Engineering Societies has begun the publication of a weekly bulletin of men available for all kinds of engineering positions, which will be of interest to all employers of engineers. The Bulletin will be available to any concern or individual regardless of his connection or lack of connection with any of the societies. Subscription to the bulletin may be made at $25 a year through the Engineering Societies Employment Service at 29 West 39th St., New York City.

Supreme Court Decides Against Chicago

The injunction granted the United States to restrain the Sanitary District of Chicago from withdrawing more than 4,167 cu.ft. per second of water from Lake Michigan was sustained by the United States Supreme Court in an unanimous opinion rendered Jan. 5. It provides that the injunction shall go into effect in 60 days "without prejudice to any permit that may be issued by the Secretary of War according to law."

It is expected that the Secretary of War will grant a temporary permit to the Chicago Sanitary District to continue its excess withdrawal for a limited period until it can make other arrangements for disposal of its sewage, although the Court in its opinion asserts that "probably the dangers to which the City of Chicago will be subjected if the decree is carried out are exaggerated, but in any event we are not at liberty to consider them here as against the edict of a paramount power."

In its opinion, prepared by Justice Holmes and in his absence read by Chief Justice Taft, the Supreme Court brushes aside the defense entered by the Sanitary District. The authority of the United States is supreme over navigable waters, it holds, adding that there is abundant evidence that the level of the lakes has been lowered by excessive diversion. The diversion also violates the treaty with Canada, the opinion states. The decision refers to delays in the lower court, and holds that the rights of no parties have been denied.

Representative W. E. Hull, of Illinois, reintroduced a bill on Jan. 6, designed to settle the controversy. The bill provides for gradual reduction of the diversion from 10,000 to 7,000 cu.ft. per second. The district in the meantime would be required to construct adequate treatment plants for disposal of sewage. Attorneys for the Chicago Sanitary District will apply for an emergency permit from the War Department, authorizing the present withdrawal of water through the drainage canal as the only possible relief from the menace to the health of the city, if the injunction affirmed yesterday by the United States Supreme Court goes into effect without modification, it is stated. Secretary Weeks has directed Major General Taylor, chief of Army engineers, to make a further investigation, the press reports.

Sperry Honors Dr. Kamo With Engineers' Luncheon

Elmer A. Sperry of gyroscopic compass and engineering fame invited a number of American engineers to meet at luncheon, at the Engineers Club, New York City, Dr. Masamo Kamo, who was president of the Japanese Society of Mechanical Engineers at the time of Mr. Sperry's visit to Japan several years ago. He is the president in office of the Japanese Association of Heating and Ventilating Engineers, was the head of the official delegation from Japan to the World Power Conference and is professor of mechanical engineering at the Imperial University of Tokio. Doctor Kamo, who has been visiting in America, expects to sail from San Francisco on the "Taiyo Maru" on Jan. 15.

Consumers Power Has New Plants

The Consumers Power Co., of Jackson, Mich., has under way a dam on the Manistee River 28 miles northwest of Cadillac on the boundary between Manistee and Wexford Counties and 12 miles upstream from the company's Junction hydro-electric plant, with which it will be connected by a 140,000-volt transmission line. The new plant is to be named after A. G. Hodenpyl, a director of the company. It will contain two 12,000-hp. vertical-shaft turbines each coupled to a 8,888-kva. Allis-Chalmers generator and will be similar to the company's Mio plant on the Au Sable River. Work on the dam, the height varying from 40 ft. to 65 ft., is proceeding rapidly. The plant is scheduled to deliver power by June 1, 1925, and to be completed next August.

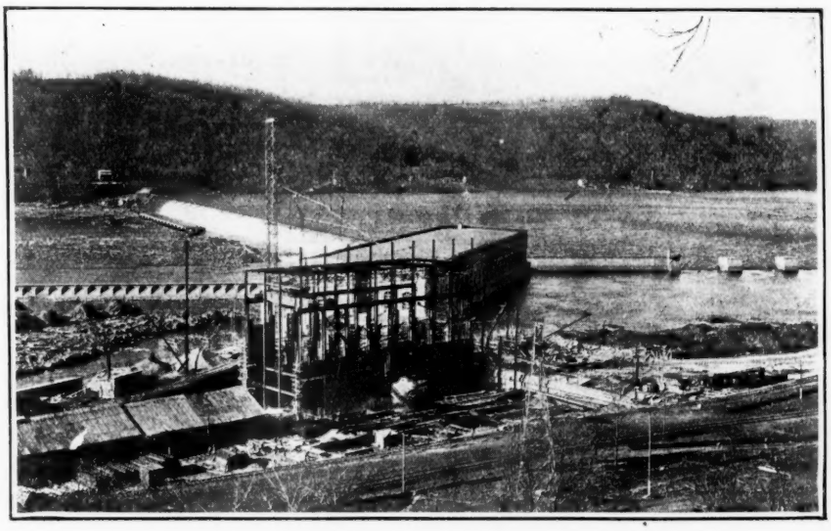
The company has purchased the power rights on the Rifle River in Michigan, extending from two miles below Sterling, Arenac County, to near West Branch, Ogemaw County. Developments will be undertaken when justified by power demand. Engineers estimate that the energy developed at four proposed dams will be about 12,000 hp. at the maximum and 3,000 hp. at lower water. Work on the four hydro-electric stations on the Tobacco and Tittabawassee Rivers, not far from the Rifle, is progressing rapidly. It is planned to have them all running next year. These will contribute about 50,000,000 kw.-hr. a year, with a possible maximum of about 70,000,000 kw.-hr. and a minimum of not less than 40,000,000 kw.-hr.

Middle West to Conserve Power Resources

States of the Middle West will be asked to join Michigan in taking up the problem of conservation of natural resources, according to recent press reports. Alex. J. Groesbeck, Governor of Michigan, has announced that he will call a conference to discuss the problem, and it is likely that Wisconsin and Minnesota will be asked to join Michigan in taking the lead in this matter. Reforestation of the northern portion of the state, protection of game and fish and development of the power resources of the state will be the important phases of the conservation program it is stated.

Holtwood Steam Plant Under Construction

As announced in the Nov. 18 issue, the new steam plant of the Pennsylvania Water & Power Co., at Holtwood, is under construction. The first installation will consist of two 10,000-kw., 80 per cent power factor turbines and three 14,900-sq.ft. boilers. The accompanying photograph shows the location of the initial installation of the new plant in relation to the hydro plant. It is on the downstream side of the wing wall leading to the hydro plant. Future extensions will be made in a northerly or upstream direction, or toward the right on the photograph, across and above the wing wall. The mill house, with an initial installation of three 57-in. Fuller screen type pulverizers will be located in a separate building above the wing wall shown at the extreme right of the photo. The Fuller system of pulverizing and transporting will be used with Lopulco furnaces and burners.



View of Holtwood steam plant, taken on Nov. 17

Electrification Planned for Pennsylvania Railroad

It is reported that the Pennsylvania Railroad will electrify its lines between New York and Washington in the near future. This involves a four-track system about 220 miles in length and an expenditure of upward of $50,000,000. It is stated that all electrical power will be purchased from utilities located along the lines.

National Boiler and Radiator Manufacturers Dine

The National Boiler and Radiator Manufacturers Association held its tenth annual dinner at the Hotel Astor on Jan. 7. John H. Waters, the first president of the association, in office during 1915, was toastmaster. He introduced the first speaker of the evening, Edward Norris, the retiring president. Other past presidents of the association and members were called upon for speeches and responded with appropriate remarks. The evening was a decided success and enjoyed by everyone present.

Chicago Power Meeting Schedule

For the second annual power meeting, to be held by the Chicago Section of the A.S.M.E. on Jan. 14-15 at the Hotel La Salle, all plans have been completed. Arrangements have been made for an interesting series of papers of current interest in the power-plant field, and there is indication that the attendance will exceed all records of the past for the section. The banquet on Wednesday evening will be one of the features of the meeting. The speakers will be David R. F. Forgan on "War and Credit" and Frank D. Chase on "The Industrial Plant and its Power." An entire session on prime movers and papers on such topics as air preheating, furnace wall cooling, combustion control and auxiliaries feature the technical program. The full schedule of events is as follows:

Wednesday Morning, 9:45: "Combustion Control," by T. A. Peebles, Hagan Corp; "Water Cooled Furnace Walls," by H. D. Savage, Combustion Engineering Corp.

Wednesday Afternoon, 1:30: "Large Steam Turbines," by Francis Hodgkinson, chief engineer of the Westinghouse Electric & Manufacturing Co.; "Unaflow vs. Compound Duoflow Engines," by Robert Cramer, consulting engineer, of Milwaukee; "The Diesel Engine," by L. H. Morrison, of *Power*.

Wednesday Evening, 7: Banquet at Hotel La Salle.

Thursday Morning, 9:45: "Preheating Furnace Air," by C. W. E. Clark, of Dwight P. Robinson Co., New York City; "Boiler and Turbine Room Auxiliaries," by G. G. Bell, manager power development, West Penn Power Co., Pittsburgh; "Features of Crawford Avenue Station," by W. L. Abbott, chief operating engineer of the Commonwealth Edison Co.

Thursday, 12:30: Luncheon at Hotel La Salle.

Thursday Afternoon, 1:30: Inspection trip through Crawford Avenue Station.

Pupin To Be President of Science Association

Prof. Michael I. Pupin was elected president of the American Association for the Advancement of Science at its seventy-ninth annual meeting held in Washington, D. C., recently. Professor Pupin has rendered distinguished service in physics and especially in the electrical field through his studies relating to electrical resonance, electric wave propagation over non-uniform conductors, energy loss in weak and variable magnetic fields and the rotation of conductors in alternating magnetic fields.

Professor Pupin has had a romantic life, being of Servian ancestry and blood, although born in Hungary and coming to America in his sixteenth year. After many vicissitudes he entered Columbia College in 1879 and was graduated in 1883. He was, after study abroad, appointed instructor at Columbia in 1889 and later on made

Michael I. Pupin

full professor of electromechanics. He is best known through his researches in long-distance telephony and through his invention of the loading coil.

No Waste at the Ford Motor Company's Plants

The Ford Motor Company has developed a byproducts business that is estimated for the coming year at $13,000,000. It is said that the remarkable feature of this business is that nearly $4,000,000 of the total comes from products reclaimed from waste.

The company has gradually taken over control of raw materials in order to insure constant and uninterrupted production. From coal and iron mining, logging, glass manufacturing and like basic industries the surplus has found ready sales in the public markets. Coke, gas, benzol and ammonium sulphite, byproducts of coal, bring in over a million dollars annually. Slag from the blast furnaces at the River Rouge is transformed into cement at a new plant having a capacity of 1,000 bbl. a day. From hardwood scrap at Iron Mountain, the largest wood distillation plant in the world, there is recovered a number of valuable products like charcoal, pitch, creosote, refined wood alcohol and acetate of lime. Surplus lumber is sold, plate glass and grades not suitable for Ford cars and small sizes are sold to minor companies; scrap metal and non-metallic materials sales are large. There is no waste at the Ford plant.

Sailless Ship Does Nine Knots on Rough Sea

Anton Flettner's sailless, wind-driven ship "Buckau" attained a speed of nine knots in a trial in a heavy sea on Jan. 6, according to press reports. When the test was ended, Flettner is reported to have said that he was satisfied with the seaworthiness of his vessel in rough weather. The "Buckau" will leave soon on a cruise to Lubeck and possibly to Sweden.

Power Tablet Unveiled at Niagara Falls

A tablet to mark the location of the first large scale hydro-electric power development was unveiled at Niagara Falls, N. Y., on Jan. 3. It is located at Power House No. 1, the building in which, thirty years ago, the world's first 5,000-hp. hydro-electric generators were installed. At that time three units with a combined output of 15,000 hp. were put into service. Now in a nearby power house three units are developing 210,000 hp. and the total output on the American side is nearly a half million continuous horsepower.

Obituary

John M. Diven, secretary emeritus of the American Water Works Association and superintendent of water-works, Troy, N. Y., died in Troy on Jan. 4. He had been in poor health for three months past. Mr. Diven had been secretary of the Association for 25 years and his loss is deeply felt.

Society Affairs

The Cincinnati Section of the A.S.M.E. will have as the attraction for its Jan. 22 meeting, "Demonstration of New Heat-Resisting Steel," by J. G. Donaldson, Mosler Safe Co.

The Gas Products Association, the trade association of the oxyacetylene industry, will hold its mid-winter convention at Hotel Sherman, Chicago, Jan. 22-25. Charles T. Allen is secretary and the executive office is at 140 South Dearborn St., Chicago.

The Metropolitan Section of the A.S.M.E. will make an inspection trip to the Hudson Avenue power station of the Brooklyn Edison Co. at 4 p.m. on Jan. 21. A lecture on the construction and operation of the power house will follow in the evening at the company's auditorium.

The Plant's Engineers Club (Boston) will hear John H. Damon, of the Plymouth Cordage Co., Plymouth, Mass., on "Bonus Systems in Boiler Rooms," at its informal dinner meeting at the Boston City Club on Jan. 14. Discussion will be led by Howard T. Chandler, of the Walter Baker Co., and Paul Cheever, of the Merrimac Chemical Co.

Personal Mention

Prof. James F. Norris, of **M.I.T.,** has been elected president of the American Chemical Society for 1925.

C. B. Starr, mechanical engineer, has recently joined the Robert June Management Organization, 8835 Linwood Ave., Detroit, Mich.

Edward T. Moore has opened an office at 500 Cahill Bldg., Syracuse, N. Y., for the general practice of consulting engineering and the manufacture of the Moore electric power regulator. Mr. Moore will specialize in industrial plant problems and electric furnace installations.

P. Albert Poppenhausen, president for many years of the Green Engineering Co., is re-entering the power-plant field with an experienced organization for selling and installing power-plant equipment. It is expected that the organization will be perfected in a short time. The present address is at 200 East Pearson St., Chicago.

Hartley Rowe, Walter W. Cook and William H. Rose have been appointed directors of the Lockwood, Greene & Co., Engineers, 24 Federal St., Boston. Mr. Rowe will continue as manager of the Boston office; Mr. Cook continues as manager of the architectural department with headquarters at Boston; General Rose becomes a vice-president of the company with headquarters at Chicago.

Business Notes

The International Oxygen Co., Newark, N. J., announces that John Heller, for a long time one of the directors of the company has been appointed sales manager.

The Diamond Power Specialty Corp., Detroit, Mich., announces the appointment of the Midwest Machinery Co., 101 South Main St., St. Louis, Mo., as its representative for the territory of Missouri, adjacent to St. Louis, south of and including Springfield and Decatur, Ill.

The General Electric Co., Schenectady, N. Y., announces that Henry W. Darling, who for more than thirty years has been treasurer of the company, has resigned and on Jan. 1 will be succeeded by R. S. Murray, who has been assistant treasurer of the company since 1910.

Jackson & Moreland, engineers, Park Square Bldg., Boston, Mass., announce the formation of a department particularly devoted to investigations and reports of a special nature, such as appraisals and rate studies, organization and personnel matters. This department will be under the direct management of Frank M. Carhart.

Coming Conventions

American Boiler Manufacturers Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Midwinter meeting at Cleveland on Feb. 12.

American Ceramic Society. R. C. Purdy, Lord Hall, Ohio State University, Columbus, Ohio. Convention at Columbus, Ohio, Feb. 16-21.

American Engineering Council. L. W. Wallace, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 16-17.

American Institute of Consulting Engineers. Philip W. Henry, 111 Broadway, New York City. Meeting at the Union League Club, New York City, Jan. 19.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at New York City, Feb. 9-13.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 16-19.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, N. J., June 22-26.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 33 West 29th St., New York City. Annual meeting at Boston, Jan. 28-30.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

Canadian Association of Stationary Engineers. Geo. J. Soucy, 48 Moore Ave., Toronto, Ont., Secy. Convention at Windsor, R. M. McLaren, 160 Doorcourt Rd., Toronto, Ont., June 29-July 1.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Que. Annual meeting at Montreal, Que., Jan. 27-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Des Moines, Iowa, Jan. 27-30.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **New England States Association** at Worcester, Mass., June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

National Marine Engineers Beneficial Association, Geo. A. Grubb, 313 Machinists Building, Washington, D. C. Convention at Hotel Franklin Sq., Washington, D. C., Jan. 19.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Western Association of Electrical Inspectors. G. M. Miller, 1304 South 7th St., Louisville, Ky. Annual convention at the Brown Hotel, Louisville, Ky., Jan. 27-28.

Trade Catalogs

Motors — Diehl Manufacturing Co., Elizabeth, N. J. Bulletin No. 1652, "Industrial and Marine Applications of Diehl Electric Motors," is well illustrated and contains descriptions of the application of this equipment.

Boilers—Heine Boiler Co., St. Louis, Mo. Bulletin No. 52 describes the longitudinal drum boilers, H-type, horizontally baffled, and HC-type, cross-baffled. The descriptions and illustrations are interesting and well presented.

Blower—L. J. Wing Manufacturing Co., 352 West 13th St., New York City. Bulletin No. 26A "Wing Type EM Blower for Burning with Economy Small Anthracite, Screenings and Slack," describes and illustrates the advantages of this type of blower.

Tools, Portable Electric—The Black & Decker Manufacturing Co., Towson, Md. Catalog No. 8 "Portable Electric Tools and Shop Equipment," includes descriptions of drills, grinders, valve grinders, tappers, screwdrivers, socket wrenches, drill stands and electric bench and pedestal grinders.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal, Net Tons	Market Quoting	Dec. 29, 1924	Jan. 5, 1925
Pool 1	New York	$2.95	$2.95
Smokeless	Columbus	2.10	2.10
Clearfield	Boston	2.40	2.15
Somerset	Boston	2.50	2.25
Kanawha	Columbus	1.65	1.65
Hocking	Columbus	1.75	1.75
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.75	1.75
S. E. Ky.	Louisville	1.50	1.50
Big Seam	Birmingham	1.90	1.90

FUEL OIL

New York—Jan. 8, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Dec. 30, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5½c. per gal.; 38@40 deg., 6½c. per gal.

Pittsburgh—Dec. 30, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5¾c. per gal.

Dallas—Jan. 2, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Philadelphia—Dec. 30, 28@30 deg., $2.20½@$2.268 per bbl.; 18@20 deg., $2.047@$2.11; 13@16 deg., $1.89@$1.953 per bbl.

Boston—Jan. 5, tank-car lots, f.o.b.; heavy oil, 12@14 deg., Baumé, 4.37½c per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati—Jan. 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¾c. per gal.; 26@30 deg., 5¾c. per gal.; 30@32 deg., 6½c. per gal.

Chicago—Dec. 16, tank-car loads, delivered within city limits, 20@22 deg., 6c. per gal.; 24@26 deg., 6c.; 28@30 deg., 6½c.; 30@32 deg., 6¾c. per gal.

New Plant Construction

Calif., Grimes—E. Smith, 1011 Mariposa Ave., Berkeley, is having plans prepared for the irrigation of 365 acres of land in Colusa County, involving installation of one 10 and one 20 in. centrifugal pumps. Private plans.

Calif., Los Angeles—The Pacific National Bank has awarded the steel contract for the construction of a 12 story bank and office at Hill and 9th Sts., to Union Iron Works, 5125 Santa Fe Ave. Morgan, Walls & Clements, Van Nuys Bldg., are architects.

Calif., Los Banos—San Joaquin River Water Storage District, Los Banos, had estimates submitted for the construction of a dam, power house, canals, etc.; cost for the construction of a power house is approximately $2,000,000 to $2,500,000, total cost of project is approximately $30,000,000. H. Barnes, Los Banos, is resident engineer. A. Lempkey, Hobart Bldg., San Francisco, and A. J. Wiley, Boise, Idaho, are consulting engineers.

Calif., San Diego—F. A. Rhodes, manager of operation, plans to purchase pumps to be used at Chollas reservoir on city water system in supplying East San Diego section with water. Estimated cost $6,000.

Calif., San Francisco — E. Fritz, 1401 Masonic Ave., will build an 8 story apartment at Mason and Sacramento Sts., by day labor. Estimated cost $500,000.

Calif., San Ysidor (National City P. O.)— San Ysidor Irrigation Dist., plans to irrigate approximately 400 acres of land, involving 3 centrifugal pumps, 3, 4 and 6 in. direct connected to 40 hp. motors.

Calif., Yuba Clay—National Ice and Cold Storage Co., Postal Telegraph Bldg., San Francisco is having plans prepared for an ice manufacturing plant—15 tons or more daily capacity, on Almond St. Estimated cost $50,000.

Conn., Waterbury—P. H. Carroll, East Aurira St., will build a 9 story apartment on Prospect St., by day labor. Estimated cost $500,000.

Ia., Glenwood—The City voted Dec. 29 to install a deep well supply, pumphouse, etc., estimated cost $20,500. Engineer is not selected.

La., Mansura—City has voted $80,000 bonds for the construction of new waterworks and electric light plant.

Md., Baltimore — Standard Electric Machinery Co., 9 East Hill St., is in the market for transformers, single phase 25 cycle, 6600-220-110 volts; 3- 7½ kva. or 2- 15 kva, 3- 15 kva or 2- 20 kva or as alternate in 3 phase, 1- 25 kva and 1- 50 kva.

Mass., Medford—(Boston P. O.)—Syndicate c/o Tuck & Co., 636 Warren St., Roxbury, is having plans prepared for the construction of a 4 story apartment house. Estimated cost $500,000.

Mich., Detroit—Balaban, Katz & Kunsky, 501 Madison Theatre Bldg., is having plans prepared by C. W. and G. Rapp, 190 North State St., Chicago, Ill., for the construction of a 12 story theatre and office building including steam heating system and special refrigerating equipment.

Mich., Detroit—G. B. Bright Co., Engr., 2615 12th St., is preparing plans for the construction a 4 story cold storage plant, including refrigerating equipment, for use by produce dealers, estimated cost $1,000,000. Owner's name is withheld.

Mich., Jackson — Consumers Power Co., Michigan Ave., is having plans prepared for the construction of a 10 story, office building including steam heating equipment on Michigan Ave. Estimated cost $500,000. Private plans.

Mo., Elsberry — Lincoln County Rice Farming Co., c/o A. V. Rowe, will build an irrigation system consisting of 7 mi. main channel, 60 to 75 ft. wide, laterals, 3 pumping units, 10,000 g.p.m. each, etc., by day labor.

Mo., Fulton—State Eleemosynary Institute, Jefferson City, plans the construction of a power plant at the State Hospital for Deaf and Dumb School. Estimated cost $150,000.

Mo., St. Louis—E. Horton, 4188 West Belle Pl., will soon take bids for the construction of an 8 story, hotel on Finney and Pendelton Aves. Estimated cost to exceed $1,000,000. Private plans.

Mo., St. Louis—The Local Realty Co., c/o W. M. Louderman, Bank of Commerce Bldg., has awarded the contract for the construction of a 12 story, 88 x 106 ft. office and store at 11th and Locust Sts., to J. B. Masonry Constr. Co., Arcade Bldg. Estimated cost $750,000.

N. Y., Brooklyn—Kew Court Corporation, c/o Slee & Bryson, Archts, 154 Montague St., will soon take bids for the construction of a 6 story apartment house on East 22nd Et. Estimated cost $175,000.

N. Y., Buffalo — Sovereign Apartments Inc., 892 Main St., c/o Lewis & Hill., 892 Main St., Archts., awarded the contract for the construction of a 5 story hotel on West Utica St., to M. M. Robinson, 437 Woodward Ave., Detroit, Mich. Estimated cost $500,000.

N. Y., Buffalo—State Hospital Comn. Capitol, Albany, is receiving bids until Jan. 21, for heating work, additional boiler capacity, etc., at State Hospital here.

N. Y., Buffalo—Worth Trush, 944 Lafayette Ave., plans the construction of a 10 story hotel on Main St. Estimated cost $800,000.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.

Everything possible is done to insure authenticity and timeliness.

Your co-operation is invited in helping us maintain this service at the highest efficiency.

BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

N. Y., New York—Cornish Arms c/o W. H. Jackson, Archt., 1834 Broadway, is having plans prepared for the construction of a 12 story hotel at 311 West 23rd St. Estimated cost $650,000.

N. Y., New York—B. and O. Nelberg Co., c/o D. S. Lang, Archt., 110 West 34th St., will build a 6 story apartment at 193rd St. and Broadway, by day labor.

N. Y., New York—Seventy-Sixth St. and Bway. Corp., c/ R. T. Lyons, Archt., 342 Madison Ave., is having plans prepared for the construction of an apartment house at 235 West 76th St. Estimated cost $1,500,000.

N. Y., Raybrook—Supt. of Purchase, Room 408, Dept. of Architecture, Capitol, Albany, is receiving bids until Jan. 22, for water supply for cooling purposes, storehouse and cold storage building, for New York State Hospital here.

O., Cleveland—Bd. of Education, East 6th St., and Rockwell Ave., will receive bids until Jan. 19 for one booster boiler.

Okla., Oklahoma City—New State Ice Co., 2 West 3rd St., will build an ice plant including 40 ton capacity raw water ice plant, ice storage room and 150 hp. steam power plant by day labor, under supervision of Ophlus & Hill, 112 West 42nd St., New York City, New York, Engrs., Estimated cost $50,000. Refrigerating equipment to be purchased by engineers.

Okla., Stillwater—G. E. Martin, City Clerk, is receiving bids until Jan. 16, for a steam turbine generator unit, complete with foundations, condenser pumps and power wiring, unit to be 750 kw. or 937 kva. capacity, estimated cost $55,000. J. W. McLendan, Stillwater, is engineer.

Okla., Wetumka—C. Hamilton, City Clerk, City Hall, is receiving bids until Jan. 21 for 500,000 g.p.d. water purification plant, chemical equipment, etc., 3 motor driven centrifugal pumps and one marine engine unit, estimated cost $53,000; also 2 unit 400 hp. Diesel engine power plant with accessories, for electric light plant, estimated cost $63,000. V. V. Long & Co., Concord Block, Oklahoma City, are engineers.

Pa., Pittsburgh—The Homeopathic Medical and Surgical Hospital, J. H. Hammond, Pres., awarded the contract for the construction of a 7 story hospital addition on Center and Aiken Sts., to D. T. Riffle, 1006 Forbes St. Estimated cost approximately $600,000.

S. D., Faulkton—The City will receive bids until Jan. 19 for a well, 1,350 ft. deep, also heavy duty pumping equipment, etc. Dakota Eng. Co., Mitchell, are engineers.

Tex., Amarillo—Chamber of Commerce plans the construction of 2 office buildings estimated to cost $500,000 each.

Tex., Dallas—Dallas Hotel Co., c/o R. Ellifritz, Adolphus Hotel, will build a 22 story hotel on Main St., by day labor. Estimated cost $1,000,000.

Tex., Goree—City is planning an election soon to vote on $40,000 bonds for construction of a water system including pumping plant, etc. Engineer not selected.

Tex., Post—Texas Utilities Co., Ballinger, is having plans prepared for the construction of a 10 ton capacity ice plant, estimated cost $30,000. Private plans. Owner is in the market for machinery.

Tex., San Antonio — W. Rogers, 236 Hollywood St., is having plans prepared for the construction of a 15 story office building on West Commerce St. Estimated cost $925,000. H. S. Green, Alamo Bank Bldg., is architect.

Va., Old Point Comfort—Old Point Hotel Co. will soon receive bids for the construction of a hotel, at Hampton Roads waterfront. Estimated cost $1,800,000. Lannahan & Bencher, Phila., Pa., is architect.

Wash., Olympia—L. G. Vogter, 3567 East R. St., Tacoma, has filed application with State Supervisor of Hydraulics, for water appropriation on the Dosewallips River, tributary to Hood Canal in Jefferson Co., to develop a 20,000 hp. electric plant; a 50 ft. dam in Jumpoff Canyon about 200 ft. long is to impound the waters and a 2 mi. tunnel will be included in the project. Estimated cost is approximately $2,000,000.

Wis., Janesville—Rock County, c/o A. Cullen, Supt. of Asylum, has had plans prepared and will soon receive bids for the construction of a refrigeration plant, including an ice making machine, to be located at the insane asylum, estimated cost $25,000. Private plans.

Wis., Lancaster—F. Barnett, City Clerk, plans to purchase an oil engine and belt driven centrifugal pump, 500 g.p.m. capacity, or triplex pump, operated by both electric motor and industrial engines. W. G. Kirchoffer, Dean Bldg., Madison, is engineer.

Wis., Milwaukee—A. S. Alschuler, 283 East Jackson Blvd., Chicago, Ill., Archt., will soon receive bids for the construction of an 8 story, 125 x 150 ft. office and store building at 3rd and Wells Sts., for The English Woolen Mills Co., 204 Third St. Estimated cost $1,000,000.

Ont., Hamilton—S. H. Kent, City Clerk, City Hall, is receiving bids until Jan. 21 for the supply and erection of one 500,000 g.p.d. and three 1,500,000 g.p.d. vertical centrifugal sewage pumps. W. L. McFaul, City Hall, is engineer.

Ont., Owen Sound—Keenan Bros. Ltd., c/o J. E. Keenan, Secy.-Treas., is in the market for 30 to 35 hp. steam engine.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

The trend is decidedly upward in prices of most of the principal power-plant supplies. Advances were noted during the month in such items as: Cotton waste, wipers, linseed oil, red and white lead, boiler rivets, refractories, babbitt metal and cold drawn steel products. Of the materials listed in the following tabulation, the only decline occurring since Dec. 9, 1924, was a slight reduction in the price of lamps.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket	56c. per ft.
Common, 2½-in., cotton-rubber lined—80c. per ft. list less	45%

Air—Best grade

¾-in., per ft.	3-ply—$0.33	4 ply—$0.40

Steam—Discounts from List

First grade—40%	Second grade—40–5%	Third grade—40–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade—50–5%	Second grade—50–10–5%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40–2½%
Heavy	30–5%

RAWHIDE LACING—For cut, best grade, 45–5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45–5%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15@22	19.00	.14@.16
Colored	10.00@15.50	18.00	.09½@.12½

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13½ x 13½	13½ x 20½
Chicago	11.00	11.00
New York (white, at washeries)	12.00	...
Cleveland	$36.00 per M.	$50.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$1.18	$1.15	$1.25

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	16.25	14.00	17.75	15.50
White	16.25	14.00	16.25	14.00

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 60% at New York warehouses Same discount for tinned. EXTRA per 100 lb. for 1⅛ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York	$4.25	Chicago	$3.50	Pittsburgh	$2.60

Boiler rivets, same sizes:

New York	$4.35	Chicago	$3.60	Pittsburgh	$2.90

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$47@52
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	22@27
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	26@31
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	41@48
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 2nd quality, 9 in. shapes, Pennsylvana	per M	36@43
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Chrome ore crude, 40@50%	net ton	18.00@19.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	66.00	50.00
(35% tin)	28.00	20.00	28.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$4.00	$3.80
Flats, squares and hexagons, per 100 lb. base	4.65	4.50	4.30

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
2	.20	.25	.21
2¼	.23	.29	.23
2½	.24	.33	.28
2¾	.....	.....	.....
3	.30	.41	.32
3¼	.32	.47	.35
3½	.34	.51	.37
4	.43	.64	.47

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1½ in. to 2 in. diameter, 5c. per cut. 2¾ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$38.00 (net)	$ 56.50 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	25%
Coils to 1,000 ft.	55%	30%
1,000 to 5,000 ft.	60%	35%
5,000 ft. and over	60–5%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$58.92	$63.77	$9.56	$10.64	$5.52	$5.92
¾	75.35	81.90	12.58	14.01	7.88	8.45
1	108.15	117.84	18.62	20.73	10.25	10.99
1¼	146.33	159.44	24.78	27.35	14.21	15.18
1½	174.96	190.63	33.04	36.46	17.55	18.75
2	235.39	256.48	60.58	66.85	23.41	25.00
2½	372.18	405.52	99.13	109.39	33.43	35.71
3	486.69	530.30	264.34	291.70	50.14	53.56
3½	611.52	663.96	583.74	644.16	66.86	71.42
4	745.53	807.36	674.61	774.43	83.57	89.27

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60 100 Amp.
D. P. M. L.	$0 27	$0.70	$1.75
T. P. M. L.	40	1 00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2 10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$22.50
No. 16 cotton reinforced heavy	25 45
No. 18 cotton reinforced light	17.75
No. 16 cotton reinforced light	22 20
No. 18 cotton Canvasite cord	17 50
No. 16 cotton Canvasite cord	20.50

NATIONAI ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	10 ea.	.10	50	50
110 to 200	15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500)	$2.85
0–30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	32	120	75	45	.55	60
25	.27	32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1 25	1.35	24
				500	2 00	2.15	12
				750	3 50	3.70	8
				1.000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.29	$9.38	$11.28	$17.95
12	9.66	12.45	14 17	23.62
10	12.86	16.33	18.06	32.02
8	18.17	21.78	24.15	36.75
6	.....	.....	34.38	.....
4	.....	.....	47.75	.....
2	.....	.....	70.35	.....
1	.....	.....	89.73	.....
0	.....	.....	120.48	.....
00	.....	.....	144.90	.....
000	.....	.....	172.20	.....
0000	.....	.....	204.75	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¾ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.55	$0.39	$0 36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c lb.
Rubber tape, ¾ in., less 100 lb. 33c. lb., 100 lb. lots	31c lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%